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Motor Driven Centrifugal Pumps at Quincy, Ill.

By W. R. GELSTON *

Both low-lift and high-lift pumps, and booster pumps are driven by electricity. The Water Department finds these pumps "economical and very reliable and satisfactory," and the reserve steam equipment is seldom used.

Ten years ago the Quincy waterworks pumping station was equipped with four obsolete, steam-driven, duplex, direct-acting pumps, installed by the company from which the city purchased the plant in 1904. Plans were made for rebuilding the pumping station and installing modern steam-driven pumps. One-half of the old station was removed and a new fireproof building was erected in 1911. There was installed in this building a new Platt Iron Works Company, horizontal, cross-compound, crank and fly-wheel pumping engine, having a daily capacity of six million gallons. The efficiency of this engine, on acceptance test at full capacity, was

130,000,000 foot-pounds per thousand pounds of steam. The water works company paid the manufacturers \$17,980 for the pump, erected upon a foundation which was built at the expense of the water company.

By the time this installation had been completed the Keokuk hydro-electric power plant was under construction, and the promoters thereof were making contracts for the distribution of power. The Keokuk company finally made a contract with the Quincy Gas, Electric and Heating Company for the distribution of Keokuk power in the city of Quincy. The water works company then made a contract with the Quincy Gas, Electric & Heating Co. for

*Superintendent of Water Works, Quincy, Ill.



VIEW ACROSS STORAGE RESERVOIR DURING ERECTION OF TANK.
Reservoir is 320 feet wide, 420 feet long and 22 feet deep.

off-peak power at six and one-half mills per k. w. hour. Under this contract the water company uses juice for lighting the buildings and for operating filter plant motors. It was also granted the privilege of using power at the same rate for a proposed booster pumping station.

At the time the contract was made Illinois screenings were costing \$1.40 per ton delivered at the plant; a Worthington, horizontal, triple expansion, duplex, direct-acting pump was in service pumping the water from the river to the filtration plant; and the Platt Iron Works Co. machine, described above, was forcing the water into the distribution system and storage reservoir after filtration.

New pumping equipment had to be installed, and electrically driven machines could be installed at less expense than steam-driven machines, and the change could be made without scrapping steam equipment. Estimates made by the engineers indicated a saving of at least \$1,000 per year, under the new contract, by the installation of electric driven centrifugals. Accordingly two electrically driven centrifugals were installed at the river pumping station in 1915. Operating costs have changed rapidly since that time, and, although the Illinois State Public Utilities Commission increased the power rate from six and one-half to seven and one-half mills per k. w. hour on July 1, 1918, the annual saving is undoubtedly much greater now than was anticipated when the power contract was made. Unfortunately the steam equipment, which is maintained for reserve duty, has not been operated enough to furnish reliable data on present steam operating costs, and comparative figures can not be given. Therefore, data on the cost of operating the electric driven units only will be given.

LOW LIFT PUMP.

The pump that is used for lifting the water from the Mississippi river to the filtration plant is a 12-inch, single-stage, horizontal, double suction centrifugal, with a capacity of seven million gallons a day, made by the Dayton-Dowd Company, of Quincy, Illinois. It runs 750 r. p. m., and is direct connected with a General Electric Co. squirrel cage type of motor using 440-v., 3-phase, 25-cycle current.

The operating conditions are such as to prevent uniformly high efficiencies for this pump. It is located on a floor at an elevation 14 feet above low water mark in the river and may operate at one time under a suction lift of 16 feet, or, at another time, under a head of 0 to seven feet, depending upon the stage of the river. The elevation of the water in the forebay at the sedimentation basin is 51 feet above low water mark in the river. Frictional resistance in the discharge line adds about 15 feet to the total lift, and the economy of operation is still further affected by the operation of a float-controlled, hydraulic valve, which regulates the level of the water in the forebay.

During the months of March and April of the present year, the stage of the Mississippi river fluctuated from a minimum of 1.8 feet to a maximum of 19.1 feet and the average power consumption per million gallons pumped during the two months was 249 k. w. hours. The pump discharge was

measured by Venturi meter. The cost of this pumping unit complete, with necessary starting equipment, not including foundation, was \$1,485.

HIGH LIFT PUMP.

This is a 12-inch, three-stage centrifugal, direct connected with a General Electric Co. 400 h. p. synchronous motor running 750 r. p. m. The normal capacity of the filter plant is six million gallons per 24 hours, and the pump has a capacity somewhat in excess of six million gallons. The filtered water flows by gravity, under a head of from 5 to 10 feet, to the high lift pump suction. The pump discharges into the distribution system, but there is an open storage reservoir, holding about eighteen million gallons, connected with the distribution system at its highest point. The static head under which the pump normally operates is about 210 feet, varying with the depth of water in the storage reservoir. The dynamic head, affected as it is by frictional resistance and the use of water by consumers from the distribution system, averages about 230 feet. The pump discharge is measured by Venturi meter and the average power consumption is 1,130 k. w. hours per million gallons.[†]

This pump also was installed by the Dayton-Dowd Company and cost, with complete switchboard equipment, \$5,178 erected upon a foundation which was built by the water department.

CHESTNUT STREET BOOSTER STATION.

This station is located at the storage reservoir and the pumps take the water from the reservoir and boost it into an elevated tank, which serves the high section of the city. This plant was placed in operation in May, 1919.

There are two Dayton-Dowd, 5-inch, single stage, double suction, centrifugals in this service. They are direct connected with Allis-Chalmers 50 h. p. slip-ring motors running 1,440 r. p. m. Three-phase, twenty-five cycle, 440-volt current is used. The two complete units cost \$3,686. The pumps are controlled by means of Sundh Electric Co. automatic, pressure-regulated switches. One pump takes care of the normal consumption in the district, and the automatic switches are set so as to start this pump when about 8 feet of water has been used from the tank. The pump then runs until stopped by the cut-out switch when the tank is full. The switches which control the second pump are set to start and stop it at lower tank stages, and both pumps will cut in only in case of a bad fire, when one pump might be unable to maintain the supply in the tank. The pumps have capacities of about 850 gallons per minute each.

The water usually flows to the pumps under a suction head of from one to five feet. The discharge head, including friction, is 123 feet at starting and about 131 feet with the tank full. The power consumption per million gallons averages 718 k.w. hours. A Venturi meter measures the discharge. The average daily pumpage is about 200,-

[†]In a letter to the editor Mr. Gelston says: "On account of a change in the discharge head, which was brought about last summer by cleaning of mains, the pump was not operating so efficiently as before the cleaning, and we had the diameter of the impellers reduced for the purpose of increasing the efficiency. The change increased the efficiency 2½%, and we can improve it still further by cutting the impellers down still further."

000 gallons, which is about 12 per cent of all the water used by the city. In other words, all of the water used in Quincy is pumped twice and approximately 12 per cent of it is pumped three times.

On account of the automatic control at the Chestnut street station the Illinois State Public Utilities Commission would not allow the Power Company to furnish current for its operation at the contract rate of six and one-half mills per k.w. hour (changed to seven and one-half mills by order of the commission on July 1, 1918), as provided in the original contract. The following regular power rates are therefore paid for juice at this station:

	Cents
First 15 kw. hrs used per mo. for each hp. of maximum demand	6
Next 3,000 kw. hrs used per mo.	2
Next 5,000 kw. hrs used per mo.	1½
Next 8,000 kw. hrs. used per mo.	1
Next 15,000 kw. hrs. used per mo.	0.8
For all energy in excess of the above.	0.75

The rates shown are net, after allowing discount for prompt payment of the bill.

The Water Department pays the six cent and the two cent rate for practically all of the juice used at the booster station.

PLANT OPERATION.

The filtration plant and the river pumping station have capacities of six million gallons per 24 hours and are always operated at full capacity. The average daily consumption of water by the entire city is less than two million gallons. The plants are therefore in operation an average of eight hours per day, and the city is using water from the reservoir about sixteen hours per day.

On account of the simplicity of operation with electric power, only three men are regularly employed at the pumping station and filter plants. There is one engineer on duty at the pumping station, and one man attends to the operation of the filter plants while they are in operation. The third man is a night watchman, who looks after the janitor work and keeps the heating plants running in winter while the other men are off duty. One of the foremen of street work lives in a cottage at the reservoir, and he attends to the oiling of the pumps at the Chestnut street station, reads the station meters and gives the plant such attention as may be necessary from time to time.

PUMPING AND PURIFICATION COSTS.

During the first three months of the present year 187,570,000 gallons of water were pumped into the distribution system and reservoir. Of this amount 18,954,000 gallons were boosted into the elevated tank and this represents the amount of water which was pumped three times. All of the pumping was done with electric power.

In its distribution of operating expenses the Water Department charges the cost of operating the low lift pump, including a part of the engineer's salary, to the purification account. All of the cost of operating the booster station is charged to the pumping account. For the first three months of the present year the average cost of pumping one million gallons was \$15.36, and the average cost of purifica-

tion was \$16.19, making a total cost of \$31.55 per million gallons delivered to the consumer. This figure includes only the cost of labor, power, coagulants, liquid chlorine, oil waste and maintenance of equipment and plant, heat and light.

CONCLUSION.

Electric power has proven economical and very reliable and satisfactory. Lightning has occasionally caused an interruption of the service for periods ranging from a few minutes to two or three hours, and occasionally the voltage drops so low on the line as to burn out fuses; but with several million gallons of water always in storage such interruptions are not at all serious. During the summer months it has not been considered necessary to maintain banked fires under boilers. A banked fire under one boiler heats the pumping station during the winter months. Coal shortages have had no terrors for the water works officials at Quincy.

At a meeting of members of the Contractors' Association of Northern California with the State Highway Commission, the purpose of which was to discuss the mounting cost of road building from the contractor's standpoint, it was stated that the cost of labor had increased 100 per cent in the past five years. The outcome of the meeting was an agreement to appoint representatives on both sides to investigate the situation.



BOOSTER PUMPING STATION AND TANK.

Station is 26 by 34 by 11 feet; cost, \$2,241 in 1918; has room for three pumps. Tank is 41 feet in diameter and 34 feet deep, holding 300,000 gallons. Bottom of tank 100 feet above foundation. Cost in 1918, \$22,100, for tank; \$1,465 for foundation.

Hetch-Hetchy Aqueduct Tunnel

Two sections of the 18-mile concrete lined 11 feet 3 inches by 11 feet 3 inches rock tunnel through the Sierra-Nevada mountains, to deliver 400,000,000 gallons of water to San Francisco daily, are under construction from three headings with most improved and complete power plant and equipment.

Work on the eighteen-mile aqueduct tunnel from Early Intake to Priest Portal (known as the Mountain Division of the Hetch Hetchy Aqueduct) has been carried on continuously by day labor during the past year. Camps have been established at Early Intake Portal, South Fork Portal, Big Creek shaft, Second Garrotte shaft and Priest Portal. These points afford working faces on the longest units of the tunnel aqueduct.

EQUIPMENT.

Tunnel plants have been installed at the working faces, embodying the latest ideas in mining machinery. Standard equipment was selected with the idea of facilitating repairs and minimizing the stock of repair parts. This equipment includes motor-driven Laidlaw feather-valve compressors, Root rotary blowers with 20-inch air pipe, storage battery locomotives with charging apparatus, side-dump roller-bearing tunnel cars, improved Water-Leyner, Sullivan and Waugh rock drills, and air-driven drill sharpeners, with grinders, punches, etc. The track used in the tunnels is of 30-pound T-rails, laid to 24-inch gauge.

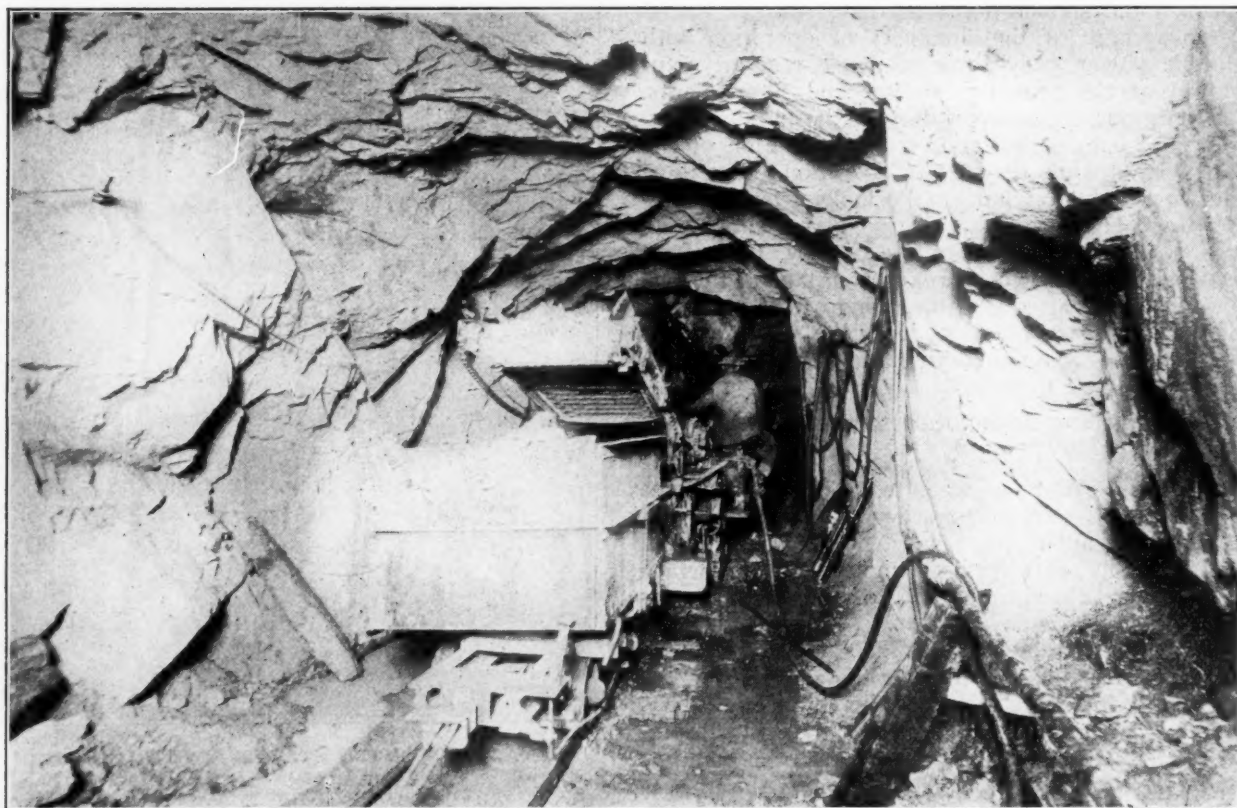
A Myers-Whaley mucking machine for loading

rock cars has been in use in the Priest heading during the past six months, and has given satisfactory service. This is in the nature of a new departure or experiment in hard rock tunnels of this size, but with the present shortage of labor it unquestionably increases the rate of progress and decreases the cost of the work.

Double-drum motor-driven reversible hoists were installed at the shafts and duplicate installation of equipment to handle the two tunnel headings working from the shaft has been made. An electric motor hoist has been installed at Early Intake tramway and a counterbalanced tramway built at Priest Portal. By means of these tramways, material is delivered from the railroad direct to the tunnel portals.

SHAFTS.

The Big Creek shaft has been completed to its full depth of 646 feet, and the excavation of chambers at and below tunnel grade preparatory to driving the headings is in progress. This shaft has a pumping station, with sump, at a depth of 330 feet. A considerable flow of water was encountered at about the 300-foot level, but moderated



MUCKING BROKEN ROCK IN TUNNEL HEADING WITH POWER SHOVEL.

at lower levels. The water entering the shaft above the pumping station is intercepted and pumped out from the station, instead of being allowed to go to the bottom of the shaft to be pumped out, thus effecting a considerable saving of power. A rock pocket, with provision for loading skips by gravity, has been excavated; also a compartment at tunnel grade, in which tunnel construction equipment can be stored and repaired.

The Second Garrotte shaft has been sunk to a depth of 277 feet. Large quantities of water have been encountered, greatly retarding progress. A pumping station with an 8,000-gallon sump has been cut at a depth of 260 feet.

DRIFTING FULL-SIZE HEADINGS.

On tunnel driving, crews of two shifts have been engaged at Early Intake, South Fork and Priest Portal. During 1919 5,542 feet of tunnel were driven and trimmed to final section, bringing the total tunnel excavated by January 1, 1920, up to 6,379 feet.

All headings are excavated to full tunnel section in one operation, using rounds of from 18 to 24 holes, with from 70 pounds to 100 pounds of 60 per cent to 80 per cent powder. An advance of about 5 feet is made per pound. The cost of labor and powder for driving this tunnel runs from \$23 to \$30.50 per lineal foot, exclusive of overhead expense, depending upon the character of rock encountered. Most of the rock is granodiorite, schist, or quartzite.

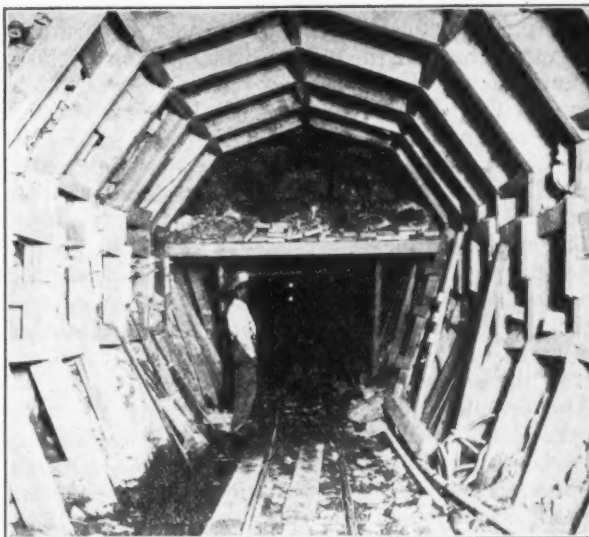
The rock removed from the Priest heading is dumped where it will form part of the down stream toe of the proposed Priest earth fill dam.

The tunnel is driven with a full width bottom heading enlarged at the top by men working on an elevated platform on which the muck is readily delivered to cars running on the service track laid on the invert. Where the rock is unsound, it is braced by skeleton timbering, consisting of light bents about 2 feet apart. Each bent is made of planks, like scarf boards of a single thickness with radial butt joints. The arch portion is made with 4 segments reaching to the springing line, below which there is on each side one vertical intermediate piece and an inclined bottom piece seated on the rock invert. Longitudinal struts or bridges are braced between the bents on the line of every joint which they cover.

SPECIAL MUCKING EQUIPMENT.

The muck is loaded into steel sidedump cars by the Myers-Whaley shoveling machine that was installed primarily on account of the shortage of labor. The machine is about 25 feet long and weighs about 9 tons. It has, at the forward end, a heavy bucket 34 inches wide which is mounted on a swinging arm with a reach of 10 feet each side of the track center and revolves in a vertical plane to empty its contents on an armored belt conveyor which, in turn, delivers to a second elevating conveyor with a transverse motion which enables it to deliver to the car waiting under it at the rear of the machine.

Only three men are required to operate the machine and attendant car, and the mechanism is con-



LIGHT ARCH TIMBERING IN ROCK TUNNEL.

trolled by two levers. The machine is driven by a 20 h. p. electric motor supplied with current from a reeled cable, and has a rated capacity for 1,000-pound loads and for handling 1 ton of rock per minute with a power consumption of 0.22 k. w. hour per ton of material shoveled.

Plastic Clay Method of Dam Construction

An impervious earthen dam 42 feet high with a volume of 45,330 cubic yards was recently built by novel methods to form part of the permanent construction of the Taylorsville earth dam across the Miami river in the Miami Conservancy District.

This dam was built nearly at right angles to the axis of the main dam and on the west bank of the Miami river. It was built during the construction of the main dam but was conducted as a separate and independent operation required to close the east end of the pool maintained in the central part of the dam for its construction by the hydraulic fill process. This dam was made of the same material as the main dam, containing a large percentage of clay, porous enough to admit at first the passage of water.

The material was excavated on the opposite shore of the river by a type 36 Marion steam shovel, which loaded into 12-yard dump cars hauled across the river by a 40-ton locomotive, unloaded by a dragline excavator and deposited by a dragline excavator in a windrow parallel to the axis of the dam. The limitations of the dragline did not permit it to deposit the material nearer than 40 feet to the foot of the western slope of the dam, but the material was made to move itself transverse to the dam axis to the required position by a very simple and effective expedient suggested by G. L. Albert, superintendent of the hydraulic fill work.

The windrow of dry material was built up to a center height of about 10 feet, and 10-foot lengths of gas pipe were driven vertically through it about 3 feet apart in a line about 2 feet east of the center

line of the windrow. Water pressure was then applied in the vertical pipes and percolated through the western half of the clayey mass making it plastic until, under the pressure of its own weight, it began to flow in the direction of least resistance, away from the eastern or dry half of the mass and moved continuously along on a very flat slope until it reached the limit staked out for the toe of the dam.

The movement was regulated by injecting more water through the pipe if it became too slow, or by dropping a windrow of dry earth at the foot of the decreasing slope if it was moving too rapidly, the dry earth serving both as a barrier and also to absorb the excess water.

The dragline machines, traveling down the axis of the dam, built up the eastern side by placing materials as required in horizontal layers 10 feet deep, while the west side was forced out to position with fresh material deposited on the slope and each bucket full jetted as it was dumped. The face of the dam was readily moved down a 4:1 slope and assumed the required 2:1 final slope.

About 35,000 yards of the material in the dam were thus deposited by the plastic method and provided an embankment so solid that a 62½-ton dragline machine moved on it without undue settlement. In a test pit excavated in the fill to a depth of 5 feet, the vertical walls stood without signs of flow or break and the damp solid material cut like a cake of putty. In a railroad cut excavated to a depth of 8 feet through the fill, the sides stood without difficulty on a 1:2 slope.

Exposure of Rain Gauges

The following is a brief abstract of a paper recently read in London by M. de Carle S. Salter, superintendent of the British Rainfall Organization, entitled, "The Exposure of Rain Gauges."

As the result of several series of experiments conducted under the direction of the late Mr. G. J. Symons, the adoption of the standard rain gauge, exposed at one foot above ground, has become general in this country. The diminution of catch in rain gauges exposed at greater heights above ground was long thought to be due to a variation in the fall at different elevations, but is now recognized as being caused by wind eddies preventing the rain from entering the funnel. Gauges sufficiently sheltered yield substantially identical results at all elevations above ground. Far too little attention has been given to the provision of proper shelter from strong wind in placing rain gauges. In inland and naturally sheltered localities this precaution may usually be neglected with impunity, but in positions near the sea or at considerable altitudes, shelter, especially on the side of the prevailing wind, is necessary. In such positions the loss caused by elevating the gauge more than one foot above the ground is greater proportionally to the degree of exposure. It is greatly aggravated in the case of snow and still more so should the gauge be of the obsolete shallow funnel type. Rain gauges should on no account be placed on sites where the land slopes downwards on the side of the prevailing wind, or near the top of a cliff or terrace. As a general

rule, the loss of catch in faultily exposed gauges occurs principally in the winter months, and, save in exceptional cases, the loss in the summer half year may be safely ignored.

Whilst avoiding over exposure it is equally important to place a rain gauge so that no part of the rain shall be intercepted by objects too near the gauge, more particularly by trees or growing plants.

The existence of errors in rainfall records due to faulty exposure is usually made apparent by the want of harmony with values at neighboring stations observed when plotting rainfall maps. A large number of instances of want of harmony have been specially investigated, the gauges in nearly every case proving to be defective, either in construction or exposure. The degree of disparity which may be taken to indicate error decreases largely with the length of period dealt with, inconsistencies of 25 per cent in a month's rainfall, not explained by the configuration, being sometimes due to variations in the actual fall, whilst in mapping the rainfall of a year, or the average of a series of years, a variation of 5 per cent would probably indicate error.

Ohio Valley Ground Water Supplies

In order to aid in the work of obtaining pure water for domestic and other uses, the United States Geological Survey, Department of the Interior, has made a number of investigations of ground water supplies in the Ohio valley, and now has available for distribution a small stock of its water supply paper 259.

The report covers about 5,600 square miles, approximately one-seventh of the state, which is densely populated. This region receives abundant rainfall, but the streams are far apart and springs few. The waters are for the most part polluted by sewage so as to render them unfit for drinking.

Most of the larger cities in the prairie region along the Ohio valley, especially in Ohio, Indiana and Illinois, are compelled to purify river water for the public supplies. Among those cities maintaining filtration systems for this purpose are Cincinnati, Columbus, Indianapolis, Louisville and many smaller towns.

Electric Lighting Industry

Substitution of hydro-electric energy for the earth's gradually depleting store of coal and oil was the principal problem considered at the annual convention of the National Electric Light Association at Pasadena, California.

In an address, R. H. Ballard, of Los Angeles, president of the association, stressed the importance of co-operation between financial interests and power companies as well as between power companies and consumers and the public in general. He also discussed the credit situation, declaring that twice as much money as heretofore would be necessary to handle even a normal volume of business. The industry needs approximately \$75,000,000 capital right now to care for the expanded requirements of the country.

Additional Water Supply for New Britain

Porous soil made it impossible to locate storage reservoirs on two of the catchment areas selected, and detention reservoirs, with pipe and tunnel connections to a reservoir in another valley, are planned. Use of ground water also is provided for. This use of detention reservoirs is a novel feature in water works.

Some features out of the ordinary give particular interest to a report submitted a few weeks ago by Allen Hazen, dealing with an additional water supply for the city of New Britain, Conn. This report is addressed to the city engineer, William H. Hall, who, with his assistants, performed a large part of the work of collecting data, making calculations, etc., in co-operation with Mr. Hazen.

PRESENT WORKS.

The municipal water works of New Britain were originally built in 1857, but have been enlarged several times since then. The water supply is obtained from seven comparatively small watersheds, with impounding and storage reservoirs, from which it reaches the city by gravity, giving pressures ranging from 20 to 111 pounds in the different parts of the city. The largest of these reservoirs is Shuttle Meadow reservoir, which has a capacity of 1,347 million gallons. Wolcott reservoir has a capacity of about 140 million gallons and Burlington reservoir about 100 million. A 24-inch cast iron main extends from Shuttle Meadow reservoir to the center of the city, the reservoir being just outside the southwest corner of the city limits. Another 24-inch cast iron pipe leads to the city from Burlington reservoir, about $8\frac{1}{2}$ miles west of the city.

The present supply is sufficient to yield 7 million gallons per day in dry years. The exact rate of output is not known, and cannot be measured easily. The water is sold by meter measurement, and the amount as measured averaged 4.65 million gallons per day in 1919; but the amount used in public buildings, street sprinkling and other public purposes is not measured, and if to this be added under-registration of meters and leakage from mains, it is probable that the total consumption reaches $6\frac{1}{2}$ million gallons. It is thus apparent that there is urgent need for increasing the supply.

Most of the present sources are high in elevation, and with little population on the water-shed. Large parts of the areas are owned by the city, so that the present favorable conditions can be controlled and made permanent. These areas produce great quantities of water during the winter and spring floods and relatively small amounts at other seasons of the year. This demonstrates the necessity for storage in order to utilize the available supply. The present storage available is only 1,600 million gallons.

PLANNING FOR THE FUTURE.

Mr. Hazen's study was made on the basis of future population of 150,000 to be supplied with 15 million gallons per day. To develop this quantity and maintain it in a dry year, it will be necessary to have 5 or 6 billion gallons of storage. His calculation of available supply is made on the basis of an average annual "water crop" of 23 inches of run-off, or 400 million gallons per square mile.

Although much of the spring floods is now lost for lack of storage, there is deep sand over much of the water-shed area, and the natural flow of the brooks is well maintained in dry seasons. It was calculated that 90 per cent of the entire run-off, less evaporation, can be made available by a net storage equal to 82 per cent of the mean annual flow—that is, a storage adequate for 335 days' consumption. This may be taken as the approximate economical limit for present local conditions.

Shuttle Meadow reservoir gives relatively adequate storage capacity for the area directly tributary, which area includes 1.4 square miles the run-off from which is collected by two canals, which conduct the water to this reservoir. Two other considerable areas, however, known as the Whiggville and Burlington Brook areas are provided with little storage. For this reason it suggested itself that the most desirable location for additional storage would be on these areas. The 24-inch line now leading from the Burlington reservoir would suffice for a number of years to bring to the city the water from these areas.

Three sites for storage reservoirs on these areas were studied. "The one on Burlington brook looked most promising. An excellent basin of ample capacity could be controlled by a relatively small dam at a point where the brook flows over rock bottom. Everything above the surface of the ground was favorable. The geological arrangement underground, as disclosed by the borings, is most unfavorable. The hill on the right bank of the brook is coarse sand and gravel. The brook runs through a rock saddle which was the prospective dam site; but borings show that this saddle is not at the lowest point of the rock. Farther up the stream there is another and lower outlet to the right, filled with well-drained sand and gravel which is capable of carrying away large quantities of water if a reservoir were built on this site.

"The samples which I examined showed material, much of it with effective sizes which I esti-

mated to be 0.5 mm. and some of it coarser. Mechanical analyses were not made because, on inspection of these materials and on studying the borings, it was apparent that a storage reservoir could not be built upon this site.

"It should be stated that it was not merely a matter of added difficulty and expense. The gravel-filled valley is so wide and deep that it would be impracticable to secure a suitable cut-off, and the material now filling it is so coarse in grain that a reservoir built without such a cut-off would leak too badly to be useful.

"The idea of building a storage reservoir on this point was therefore reluctantly abandoned.

"It then seemed that the most promising site for a reservoir to give a large part of the required storage was below Whigville. Surveys were made of this site and borings were made where a dam could be located. In this case also the borings disclosed sand and gravel of such a degree of coarseness and of such depth as to make the construction of a dam and reservoir impracticable.

"As the reasons for not using these sites may be questioned in years to come by others not familiar with the present circumstances, it is my suggestion that record plans showing all the data should be made and placed in your files, and that the samples of materials taken from the borings, and now in the City Hall, should be preserved to satisfy those who come after."

DETENTION RESERVOIRS.

"With these two sites eliminated, there remained only the Harts Mills site, and here also conditions were not very favorable. In this case the left bank of the stream is a sand and gravel bank. The brook runs through a rock saddle which makes an attractive dam site. No large amount of storage can be secured in a reservoir built on this site, nor is there assurance that the dam can be made tight, but it is proposed to use it, building a dam of moderate height for the purpose of retarding the flow of flood waters and permitting them to be diverted through a smaller pipe than would otherwise be needed.

"Used in this way, the Harts Mills reservoir will only be filled during periods of ample flow. Otherwise it will stand empty. Seepage from it is to be expected, but the seepage will be to the present Whigville reservoir, and the water will be ultimately saved." A capacity of 264 million gallons is planned for this reservoir. The average annual yield of this shed is estimated at 1,500 million gallons.

The stream flowing through the proposed Harts Mills reservoir and through the existing Whigville reservoir lower down is separated from Burlington brook by high land, and the plan proposed is to bring the water from the Burlington brook to the Whigville reservoir by means of a tunnel 4,700 feet long with an approach channel and a small diverting dam. This tunnel was considered preferable to a much longer pipe line around the hill, and further, it would not be practicable to build a pipe line large enough to carry the flood flow of Burlington brook, while the tunnel will carry practically all of such flow. As a possible alternative to the tunnel, Mr. Hazen suggests a small detention reser-

voir on the brook lower down and a pipe line or canal leading to a new intake dam. The annual yield of this area is estimated at 1,720 million gallons.

None of these reservoirs, however, provides much additional storage, and it was decided that the only practicable storage obtainable was at Shuttle Meadow, where the existing dam could be raised considerably, and the reservoir area greatly increased. The only disadvantage is that it is separated from the catchment areas that will furnish most of the water. "This defect can be corrected by providing pipes of capacity sufficient to carry the greater part of the flood flows. Pipes large enough to carry extreme flood flows would be too expensive; but by securing a certain amount of retardation of flood flows by relatively small reservoirs, pipes of moderate size can be made to carry a large percentage of the water to the point of storage.

"Diversion of the flows in this way presented an interesting and somewhat novel problem in hydraulics. The question was to find how large the pipe capacity must be, and the effect of a retarding reservoir; and in short, to find the most economical combination of pipe line and reservoir that would give sufficiently complete development."

In making this study, use was made of the records of flow in the Manhan river, which is part of Holyoke's supply, the records of which had been kept for 19 years. Conditions on this stream are so closely comparable with the Whigville and the Burlington areas, that this basis of estimate was used with confidence.

Calculations were made to determine "the most economical sizes that would secure the diversion of all the water that it would pay to divert, without, on the other hand, going to extremes that would make the cost of the last water excessive." As a result of this study, Mr. Hazen states that it is possible to divert 98 per cent of the flows of the Whigville and Burlington areas above the present Whigville dam, by the use of detention reservoirs of practicable size and pipes from them to the Shuttle Meadow reservoir.

From the detention reservoir at Harts Mills, a 36-inch pipe line would be laid (passing the present Whigville reservoir and having a cross-connection with it) for a distance of about 7 miles, where it would be cross-connected with the 24-inch pipe from the Whigville reservoir. Here the line would be increased in size to 42-inch and carried 4 miles further to the back end of Shuttle Meadow reservoir. By this arrangement the combined capacities of the present 24-inch pipe and the new 36-inch pipe from Harts Mills and Whigville reservoirs would both be utilized, and the supply from both would be carried by the 42-inch to the Shuttle Meadow reservoir. By this method the run-off from the Burlington and Whigville areas will be brought to the large storage reservoir proposed at Shuttle Meadow.

In addition there is an area of about 11 square miles below the Whigville dam which it may seem desirable to make use of. The only method practicable for doing so appears to be to locate a pumping station at the lower end of this area and to

pump the water from there into Shuttle Meadow reservoir.

SHUTTLE MEADOW RESERVOIR.

Shuttle Meadow is a natural basin almost surrounded with high walls of trap. The floor of the enclosed valley is almost flat. The present reservoir is formed by a relatively low dam. By building a higher dam, the capacity of the reservoir can be greatly increased.

Surveys made to determine the capacity of the reservoir and the dimensions of the dam required, if the reservoir be raised 50 feet above its present level, showed that this will increase the storage to 6,000 million gallons and permit a delivery of more than 18 million gallons a day. There is no apparent reason why the reservoir could not be built 80 feet above the present level and the storage capacity thus be increased to 10,000 million gallons.

"The dam site is between masses of trap rock at either end. The few borings that were made disclosed red sandstone rock underneath the site at a depth of about 50 feet below the present floor of the valley. These borings were not numerous enough to develop all the underground conditions, and further borings along the center line of the proposed dam site will be needed before plans can be made."

The material above the rock at this point consists of clay, sand, broken rock and boulders, most of it sand containing fine material which renders it much less pervious to water than that found at the other sites. It was assumed that it would be necessary, however, to obtain a complete cut-off of underground flow by carrying to rock either an open trench back-filled with concrete or clay, or caissons, or sheet piling of wood or steel. An estimate is made of \$300,000 for cut-off works, both in the bottom and at the right bank.

This seemed a large sum to spend for this precaution, and it is possible that further borings and studies may prove it to be unnecessary. But as this reservoir is just outside the city and the topography is such that, in case of a break, the released water would pass through part of the city, it seemed prudent not only to take this precaution, but also to make the dam thicker than would be considered necessary in another location. This extra thickness of dam was also used in the design to make possible raising it to a great height in the future, if this should be found desirable. Details of the plan of the dam were not worked out, as the final design should be based upon more complete knowledge concerning the materials available in the neighborhood for constructing the dam and also the soil underneath it.

As this dam is largely in the nature of a storage reservoir rather than an intercepting one, in that it receives the direct surface flow of only about one-sixth of the total utilized area, while the flood flows on the other tributary areas are regulated by retarding reservoirs, the top need be carried only a few feet above the proposed flow line and a spillway is almost unnecessary. It happens, however, that there is on one side of the reservoir a valley through the trap rock and at the right elevation for a spillway, and this forms a natural spillway which will make

it impossible to fill the reservoir higher than is safe for the embankment.

OTHER FEATURES OF THE PLAN.

It is taken for granted that the city will desire to filter its supply, as has been done for some years at Springfield and New Haven, and as is being done at Hartford. A site was found for a filtration plant near the reservoir and at such elevation that the water from the upper 25 feet of the proposed reservoir would come to the filters by gravity. As the reservoir under normal working conditions would seldom be drawn down more than 25 feet, most of the water used through it would flow to the filters by gravity, while the rest of the water, which would be required only in dry times, would be made available by pumping. For this purpose a centrifugal pump operated by a 100 horse-power electric motor is recommended. Offsetting the necessity for occasional pumping is the advantage that having the filters at this height increases to the maximum the gravity pressure available in the city.

At present the pressure in the city is lower than is desirable, partly because the reservoir itself is rather low and partly because the pipe line from the reservoir is not of sufficient capacity. By the proposed plan the filters will be 25 feet above the present flow line in this reservoir, and a new pipe line will be built to the city, the combined result of which will be that the pressure will be about 10 pounds higher than its present maximum.

The coarse sand found at the Burlington and Whigville dam sites suggested the practicability of securing ground water by wells in this sand. Two advantages of this would be that a very considerable natural storage in the ground could be availed of, and the quality of the water would be better. Water so obtained would not need to be stored in the Shuttle Meadow reservoir nor to be filtered. It would be partly but not wholly additional to that obtained as surface water by the damming of the streams.

The water now being intercepted by two canals, one on each side of the valley, and brought to Shuttle Meadow reservoir, could not be discharged into the reservoir by gravity when the dam has been raised 50 feet, but would be discharged into a small basin at the foot of the main dam and lifted into the reservoir by means of an electric pump. Water so obtained would not cost more than \$4 or \$5 per million gallons.

ORDER OF DEVELOPMENT.

As the Shuttle Meadow reservoir is now the most important source of supply for the city, these plans must be carried out in such a way as not to interfere with the use of this supply until at least an equal amount is available in some other way. Mr. Hazen describes in some detail the order in which these plans should be carried out to secure this end.

As bringing additional run-off to Shuttle Meadow reservoir by means of the various elements of the plan described would serve little purpose unless there were storage capacity for retaining it, the first work should be the enlarging of that reservoir. First it will be necessary to drive a tunnel in solid

rock around the end of the present dam and carry it well beyond any point that may be reached by the proposed new dam; which new dam would be located just below the present one. This tunnel must be connected with the reservoir and a gatehouse provided, and also connected with the pipes leading to the city, so that the supply can be drawn through this tunnel rather than through the pipes leading from the present dam, which pipes would be removed when the new dam is started. The new dam would then be constructed.

As this work would not be completed for several years, while the consumption will be increasing, some means are necessary for adding to the supply during this interval, and it is suggested that for this purpose the development of the ground water above referred to be adopted. Two million gallons a day obtained in this way could be brought to the city by the present pipe leading from the Whigville reservoir and should suffice until the new Shuttle Meadow reservoir is ready for service.

The third instalment of work would consist of the construction of the filters. The fourth would be the Harts Mills reservoir and the steel pipe line bringing that supply to the Shuttle Meadow reservoir. The fifth and final work would be the bringing in of the Burlington brook supply by the construction of the tunnel and its appurtenances.

The cost of the whole works is estimated at \$4,800,000, of which \$830,000 is for the filtration plant. This gives a cost (including filtration) of \$409,000 per million gallons maintainable capacity. This figure seems large, but would have been not more than 60 per cent. as large if it had been made a few years ago when prices were lower.

Oklahoma Water Supply and Sewerage

The engineer of the State Board of Health describes conditions in the state at present. Most of the sewage treatment plants are so operated as to be valueless.

The engineer of the State Board of Health of Oklahoma is required by law to make a survey of the water and sewerage conditions of the state; investigate all water supplies in the state to determine whether or not the public health is endangered by the poor quality of the water and order changes necessary to safeguard the public health; investigate all sewer systems and sewage treatment works to determine whether the public health is being endangered by stream pollution and order the necessary remedies; make tests to determine the best method of purifying water and sewage; and pass on all plans for new work in water supply and sewerage. As the engineer, J. W. Evans, has no assistants, although he reports that six sanitary engineers would be required to perform all of this

work, he has found it possible only to pass upon new plans and make partial investigations of water and sewer systems up to date.

OKLAHOMA WATER SUPPLIES.

In the report published this year and brought up to March, he gives a general summary of the water and sewerage situation in the state. There are at least 233 and probably a few more water supplies in the state, practically all municipal, only three private ones being known of. The municipalities supplied have a total population of about 850,000, of which 500,000, living in 75 municipalities, are supplied with surface water and the remainder with well water.

The surface waters of Oklahoma in nearly all cases either are so polluted by sewage or contain such large quantities of suspended matter that they are unfit to drink without previous purification. About 20 cities in Oklahoma are treating their water with chlorine. Most well waters in the state, and especially those in the western half, are hard and undesirable. Thirty-three municipalities using surface water are attempting to purify it, 24 of them operating sand filters and 8 merely using coagulants to settle out the impurities. There are two filters of the pressure type in use and several have been discarded. One was installed at Yale to separate mud from the water of a typical red creek without preliminary treatment, but the filter clogged in a few minutes, required about all the filtered water for washing purposes, and was soon discarded.

SEWERAGE SYSTEMS.

There are about 110 sewer systems in Oklahoma serving communities with a population of about 700,000, of which about 500,000 are connected with the sewers. The sewage is in most cases disposed of by discharge into streams, either raw or after passing through a septic tank. Many sewage treatment plants have been installed, but their purpose has generally been to protect the municipality against damage suits rather than effectively to purify the sewage. The office records show about 40 septic tanks, 15 Imhof tanks, a dozen sprinkling filters, several contact beds, 7 electrolytic plants and one activated sludge plant. Of the electrolytic plants, only one is now in operation and that only a few hours a day. The activated sludge plant is located at Yale and is not yet in operation.

From observation made on perhaps half of the plants, it appears that they "are operating at about 30 per cent. efficiency. Moreover, very few plants have been built that are really capable of getting good results, and when neglect is added to faulty design, the results are best described by the statement that the purification plant does not do the sewage much harm. It is customary to leave the sewage plant alone until a complaint is received from those offended by the sewage. Quite frequently I have found that none of the municipal officials know where the sewage plant is located. This indifference on the part of municipal officials should be considered by engineers in designing treatment works. A sewage plant should be as simple and as nearly automatic in its operation as it can be made, and definite instructions for operating the plant should be attached to the plans."

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Water Works Costs

In the annual review of certain features of water works conditions throughout the country which, in conformity with our long-established practice, we give this week, we have selected the matter of costs as being of most interest to water works officials, and present several tables showing how these have increased in all sections of the country. Roughly speaking, the increase in the materials which count most in the annual expense accounts average about 150 to 175 per cent. This is more than the general increase in the cost of labor or of living expenses, and much more than the increase made in water rates.

Next week we expect to publish additional figures from the same cities, showing to what extent water rates have been increased, and also the wages of employes and the salaries of superintendents. The failure to raise water rates will furnish food for thought, and it would seem for action also.

Detention Reservoirs

The plans of the Miami Conservancy District now being carried out provide for what are believed to be the largest dams ever constructed for the purpose of flattening out the peak of the storm run-off of a drainage area rather than for long-time retention of the run-off.

In fact, the idea is one that has not often been employed. It is therefore interesting to find, in a recent report, a proposal to embody the idea in a scheme for impounding water for a public water supply.

In the preliminary plans for New Britain described in this issue, Allen Hazen proposes using detention reservoirs in order to reduce the size of pipe necessary for carrying to a storage reservoir the total run-off of even maximum storms from drainage areas not directly tributary to such storage reservoir.

As already explained in connection with the Miami dams, the general idea is that of providing an outlet to the dam which is never closed and which will carry all of the ordinary flow of the stream, as a result of which the reservoir would

ordinarily remain entirely empty. During storms, however, all of the run-off would not be passed by the outlet as rapidly as it reached it, but the surplus would accumulate in the reservoir, to flow out gradually, as the storm flow decreases, at such a rate as the capacity of the outlet permits.

In the plans for New Britain, the outlet consists of a pipe carrying to a storage reservoir the run-off from a drainage area which would not otherwise reach it. This pipe would ordinarily carry the entire flow from such area and it is only when its capacity is exceeded by storm run-off that the surplus would accumulate in the reservoir. If the reservoir were not provided, or were merely a small intercepting one, the pipe would need to be very much larger and more expensive, or else a considerable part of the excessive run-off would fail to enter the pipe and would be lost. From the point of view of economy, it is possible to so proportion the size of pipe and capacity of reservoir, increasing one and decreasing the other, or vice versa, as to reduce to a minimum the combined cost of the two.

Another advantage of detention reservoirs is that they greatly reduce the capacity necessary in the waste weir of the storage reservoir, since they hold back temporarily from such reservoir the maximum floods. In fact, it suggests itself that it might be advantageous in some cases to build, on each of the several tributaries to an impounded stream, a dam of cheap construction which need not be made water-tight, such as one made of logs or rock fill, but which would be sufficiently tight to hold back temporarily the storm run-off from the area above it.

The idea is most interesting, and is one which may find additional applications in the designing of hydraulic works where conditions are favorable to its adoption, as they were at New Britain.

Preserving Records of Investigations

Another feature of the New Britain report which deserves mention is the suggestion of the engineer that the results of the investigation which has been made, including all data and samples of materials from borings, as well as the conclusions, be preserved by the department as a part of its records "to satisfy those who come after," "as the reasons for not using these sites may be questioned in years to come by others not familiar with the present circumstances."

It has happened several times that studies made for municipalities or states and which have resulted in conclusive determinations for or against certain proposals, have been filed away and, the officials connected therewith having changed during the next few years, the taxpayers' money has been wasted by again investigating the same projects and with similar conclusions. Or, as has more frequently happened, the conclusions having been acted upon, new officials ignorant of the reasons for reaching these conclusions have questioned their wisdom and may even have undone work already performed on them and thus incurred a loss which would not have happened had they been able to review the facts and reasoning on which such conclusions were based.

It is the duty of every engineer to his client to make thorough investigation of problems on which he reports and have clear and definite reasons for his conclusions; and the data as well as the conclusions should be furnished in full to the client. The engineer owes it to himself to report the data and reasoning and to do all that is in his power to see that they are permanently recorded, in order that they may serve as a defense of his reputation in case the wisdom of his decision should be called in question by succeeding officials. A further reason for this preservation of such records in their entirety is in order that they may be used understandingly and with confidence by succeeding investigators of related problems or of extensions of the same problem. In fact, this last is perhaps the use that will most frequently be made of data so preserved.

Recent Immigration Figures

Immigration at Ellis Island, which receives approximately 80 per cent. of the immigrants reaching this country, continues to show an encouraging increase. While during the whole of 1919 only 141,132 immigrants were received at all ports, about 150,000 landed at Ellis Island alone during the first five months of 1920. The encouragement of this figure is partially off-set by the fact that of this year's number, about half have been widows and small children, and therefore of little industrial value to the country. Most of the others have been Italian reservists who have been here before as laborers and know beforehand what and where they expect to work.

The figures for this year are as follows: January, 25,051; February, 22,086; March, 29,098; April, 36,958; and May (figures not yet available) will total over 40,000. Byron H. Uhl, Assistant Commissioner at Ellis Island, states that he looks for about 50,000 in June and still larger numbers during July and August.

Figures published by the Bureau of Immigration covering the one hundred years ending with 1919 show that the total immigration during that time was 33,200,103, of which Great Britain and Ireland contributed 25 per cent, Germany 16 per cent, Italy and Austria-Hungary each about 12 per cent, Russia 10 per cent and Scandinavia 6½ per cent. 1914 was the record year with a total of 1,218,480, with 1913 next highest when 1,197,892 immigrants were entered. These figures are for the entire country and not the port of New York alone. In 1913, 23 per cent of the immigrants were Italians, while in 1919 only 1.3 per cent of the 141,132 were of that nationality.

Federal Labor Court Proposed

Establishment of a federal court of industrial relations, similar to that in Kansas, was recommended before the senate labor committee May 21, by Governor Allen, of Kansas.

"I would recommend legislation that would take into consideration the fact that the peace and welfare of the public must come first," said Governor Allen.

"I would urge the creation of a court having all the powers of any court below the supreme court, whose appeals should be to that tribunal; the judges to be appointed by the President."

The Governor said, however, that this court should have jurisdiction relating only to interstate commerce and that there should be no provision that would in any way interfere with the rights of states to adopt similar measures dealing with intrastate commerce.

Philadelphia Longshore Strike

The United States Shipping Board has issued the following statement:

The longshoremen's organization at Philadelphia, which is not affiliated in any way with the International Longshoremen's Association, has made a demand for a 25 per cent increase in wage rates and some 4,000 men have gone on strike. This organization was under an agreement with employers and the Port of Philadelphia, expiring Sept. 30, 1920, by which its members were assured the prevailing longshore wage rates upon the Atlantic Coast. This agreement has apparently been disregarded and great delay and damage to shipping in the Port of Philadelphia is resulting.

"The present basic deep sea longshore wage rate on the Atlantic Coast is 80 cents per hour. The demand of the striking longshoremen calls for a dollar an hour. As the present rate was set by a commission which gave careful and thorough investigation to all of the factors involved, including the cost of living, there is no justification for an increase in the basic hourly rate."

Too Much Alien Labor Leaving America

It is estimated that 200,000 Poles in the United States will return to their native country to help in the establishment of free Poland. Applications for passports to Poland are being received at the rate of 1,000 a day, but there are transportation facilities for only about 800 passengers a month.

Italians are returning to Italy in large numbers, but they are not staying. Post-war conditions in Italy apparently do not attract the Italian who has become accustomed to high wages in the United States.

Italian Immigration

The Chicago Italian Chamber of Commerce, with a membership of 175, all but two of whom are United States citizens, has submitted a resolution to Congress, calling for opposition to all bills to suspend immigration, to restrict it on a percentage basis or to subject immigrant aliens, and aliens visiting this country, to unnecessary and vexatious regulations.

It asserts that restriction of immigration on a percentage basis is openly intended to encourage immigration from Germany and restrict it from Italy.

The body also went on record in favor of Senator Kenyon's measure appropriating \$6,500,000 for Federal co-operation with the several States in the education of illiterates.

In the week ending May 29, the number of immigrants landing at the port of New York was six

times as great as those of aliens qualifying to leave the country.

Aliens are now arriving at about one-third the rate they landed here in the last year before the war. In many countries emigrants have difficulty in securing permission to leave the country where the working force has been depleted by the war and where in some cases large armies are still maintained, leaving an inadequate provision for civil operations, which are much more highly paid than formerly and this also tends to decrease the incentive for emigration. In Poland 8,000 passports were issued during the month of May.

P. A. Baker, superintendent of U. S. Immigration Station, Ellis Island, says that immigration is increasing by leaps and bounds and that the aliens arriving here during the past few weeks have exceeded the number departing for their native lands by many thousands.

On its last arrival in New York, the liner Henry R. Mallory brought 1,000 former Italian soldiers all able-bodied and ready for work, which, it is reported, they obtained without leaving the dock, where they were met by the representative of a large rubber company who offered them satisfactory employment.

Water Resources of North Carolina

The State Geological and Economic Survey is to investigate the water resources for power and municipal supplies, studying drainage, flood control, irrigation, rainfall, stream flow, etc.

The following notice has been sent to municipal officials of Carolina, under date of April 29th, by Joseph Hyde Pratt, director of the North Carolina Geological and Economic Survey:

The North Carolina Geological and Economic Survey is about to initiate a thorough study and investigation of the water resources of the state. This will include such subjects as water power, municipal water supply, drainage, flood control, irrigation, the compilation of rainfall and stream flow data, etc. The investigation will be undertaken by dividing the state into districts, each one of which will be investigated and a report prepared. Work will be undertaken first in such districts as apply, in the order of their application for service, and in the general degree of importance which the investigation would have to the people of the state. Municipalities, chambers of commerce, manufacturers, agricultural associations, and individuals may make application for one or more specific purposes. A field party will begin in June to conduct investigations.

Expenses.—The applicant will be expected to defray 50 per cent of the field expenses for such an examination. This is necessitated by the small

amount of funds appropriated for this important work.

Waterpower.—North Carolina is rich in waterpowers of less than 5,000 horsepower. There are numerous municipalities and industries in the state which could obtain their light and power cheaper by local hydro-electric development. Indeed, in some instances industries have left the state because they could not get adequate power, although undeveloped waterpowers were near by. The increasing cost and difficulty in obtaining coal have made the development of our waterpowers imperative. Moreover, on account of the increasing use of electricity on the farm, it is of great importance that our agricultural population should benefit by the natural resources of the state, which are only awaiting development. It is for these reasons that the "Survey" is undertaking this study and investigation. It is prepared to co-operate with one or a number of towns or industries in the development of local waterpowers.

Water Supply.—With the rapid growth of our towns and cities, the problem of an adequate water supply is becoming increasingly acute. The "Survey" will co-operate with municipalities in an investigation of the water resources of a district suitable for water supply and will suggest methods best adapted for the utilization and development of these resources.

Drainage.—The "Survey" has investigated and been instrumental in the creation of the great drainage projects now under way or completed in the state. It will gladly aid similarly in the formation of new districts and in the promotion of drainage work for malaria prevention.

River Regulation for Flood Control and Navigation.—The regulation of the flood flow of streams to prevent damage to municipalities or agricultural lands is becoming of increasing importance. It is frequently possible to combine this improvement with one of the other developments described above. In certain parts of the state, notably on the Catawba, waterpower developments have served to regulate the flood flow and prevent much damage which previously occurred to farm lands, towns and structures at high stages of the river.

The increasing agricultural and industrial development of the state has necessitated greatly increased facilities for transportation of products. In some instances this can be met by improving the existing waterways of the state, so that they may be more suitable for navigation. The "Survey" is prepared to investigate and report upon the feasibility of projects of river regulation for flood control or navigation.

Flood Control and Forestry.—The maintenance of a satisfactory forest cover on the watersheds is of vital importance in the regulation of stream flow and control of floods. The Federal government has already purchased in North Carolina 350,000 acres of mountain land and is protecting it for this avowed purpose. The state should at once adopt a similar policy. The protection of private lands on the headwaters of streams, through co-operation

between the owner, the Federal government and the state, is now being worked out. The effect of the destruction of the forest (mainly through uncontrolled lumbering and forest fires) upon stream flow and erosion of valuable agricultural lands will be further investigated by the "Survey" and the results laid before the people.

Delay in Starting New Highway Work

In spite of the millions of dollars available for highway construction this year, there has been a most unusual delay in awarding contracts for new work in the eastern states. In fact, Commissioner Green of New York State has been quoted as saying that he does not intend to award any contract for new work to be performed this year, one of the reasons which he advances being that there is a large amount of work yet to be done on uncompleted contracts hanging over from last year, and even before then, and that these will probably suffice to use all of the available labor and material; while the awarding of new contracts at higher rates would probably result in the new contractors' being able to out-bid those endeavoring to complete

old contracts in the securing of both labor and material, and thus in working an added hardship to the latter class of contractors and possibly further delaying or even entirely preventing the completion of the older contracts.

It is probable that the same arguments influence to a greater or less extent the highway authorities of other states in causing them to defer the awarding of contracts, although such decision has undoubtedly been influenced considerably by the high bids and the small number of bidders. For instance, of 39 total items on which bids are to be opened on June 15 at Harrisburg, Pa., 22 are re-advertisements, and on several, bids have been requested a number of times since last July. One of the items is now being offered for the ninth time, there having been received on it, during the previous eight times, 1 bid, 2 bids, 3 bids, 3 bids, 2 bids, no bids, no bids and 2 bids, respectively. Another item has already been up for contract seven times, no bids having been received the first 6 times, and only two bids the 7th time. Each of these two items consisted of one-course reinforced concrete, as does a large part of the work offered for contract by the Pennsylvania Highway Department.

Prices in 1914 and Now

Figures furnished by water works officials in all parts of the country, giving prices paid in 1914, 1919 and 1920 for various materials, fuels, electric current, etc., show that these have more than doubled in price. The figures are tabulated on the following pages.

In order to obtain some definite information from all sections of the country concerning increased cost of water works materials and to learn whether prices had apparently begun to fall in any section, last month we sent a questionnaire to superintendents throughout the country, and publish in this issue a tabulation of the replies which we obtained in this way.

The prices asked for were those for cast iron pipe and special casting, wrought iron or steel pipe, meters ($\frac{3}{4}$ -inch being taken as the size for comparison), valves (6-inch being used for comparison), fire hydrants (those with two hose and a steamer outlet being taken for comparison), lead, coal, electric current, fuel oil, and lime and soda ash used by purification plants.

Every one of the materials named showed not only an increase in price in 1919 over 1914, but also an increase in 1920 over 1919, indicating that at the time of making purchase or giving contracts during the present year, prices had not declined since last year. There were a few instances in the case of some of the materials where slightly lower prices were obtained this year than last, and quite a number where the prices this year were the same as those of last; but in the great majority of cases this year's prices showed an appreciable increase over last year's.

Averaging the prices paid by the several cities in each of the three years, we find the following results:

Cast iron pipe in 1914 brought an average price of \$26.25 per ton. By 1919 the price had risen to \$61.50, and this year the average of the prices reported from all sections of the country is \$74.81—an increase of 185 per cent over the 1914 price.

The special castings have increased a little less—170 per cent since 1914; the prices paid, in cents per pound, being 3.08 in 1914, 6.49 in 1919 and 8.32 in 1920.

The prices given for wrought iron or steel pipe were for so many different sizes that it is useless to average them; but the increase between 1914 prices and those of 1920 was obtained for each city and the average of these percentages of increase is 116, the percentage of increase for the individual cities varying from 19 to 220.

$\frac{3}{4}$ -inch meters were reported as costing an average of \$10.16 in 1914, \$12.89 in 1919 and \$14.77 in 1920. These figures give an increase of 27 per cent between 1914 and 1919, and 45 per cent between 1914 and 1920.

6-inch valves were reported as costing on the average \$11.82 in 1914, \$22.84 in 1919 and \$24.46 in 1920; this showing an increase of 93 per cent between 1914 and 1919, and 107 per cent between 1914 and 1920.

Fire hydrants were reported as costing on the average \$30.64, \$54.96, \$60.17 for the three years, respectively, showing increases of 79 per cent in 1919 and 96 per cent in 1920.

Lead is reported as costing, during the three years named, 5.01 cents, 8.05 cents and 10.35 cents; showing an increase of 61 per cent and 107 per cent for 1919 and 1920, respectively.

The prices paid for coal vary considerably in different parts of the country, and according to kind of coal used, the prices reported for 1914 varying from 60 cents to \$9.12 a ton. An average of all the prices reported between these limits would, therefore, have no special significance; but as practically all of the cities reported the prices paid in each of the three

PRICES PAID FOR WROUGHT IRON OR STEEL PIPE. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Unit	Average Price Paid in		
		1914 Cents	1919 Cents	1920 Cents
Alabama:				
Mobile	¾" per foot	3.75	.....	8.38
California:				
Palo Alto	2" galv. ft.	12	28.7	.....
Connecticut:				
Putnam	ft.	5.1	10.6	12.2
Southington	1" pipe ft.	7	12.9	12.7
Delaware:				
Lewes	3" & 6" pipe, ft.	38-32	65-150	75-170
Wilmington	¾"	5.5	10	10.5
Georgia:				
Thomasville	¾" galv. ft.	4.07	8.51	8.91
Idaho:				
Lewiston	Conv. joint g & d ft.	32.30	60.50	75
Weiser	¾" ft.	4.5	.....	10.5
Illinois:				
Bushnell	ft.	.....	.....	115
Du Quoin	ft.	4.25	6.5	8.3
Indiana:				
Evansville	ft.	6.5	13	14
Terre Haute	¾" galv. ft.	5	10.17	10.8
Iowa:				
Sioux City	2" ft.	18	22.5	26
Kansas:				
Fredonia .....	.....	8	11.5	.....
Fort Scott .....	.....	3	.....	8.5
Louisiana:				
W Iberia .....	.....	8	.....	13
Maine:				
Lisbon Falls .....	.....	.....	12	11
Maryland:				
Hagerstown	1" galv.	12	22	22
Massachusetts:				
Athol	ft.	6.50	11.50	11.50
Mansfield	ft.	.....	.....	8.74
Maynard	ft.	.....	.....	15
Millbury .....	.....	3.91	11.50	.....
Somerville	galv. ft.	1"-5.4	.16	.13
Springfield	ft.	2"-15.6	.38	.....
Woburn	ft.	7.3	16.83	18.53
Worcester	ft.	1"-3.5	37.00+2%	7-8
Michigan:				
Battle Creek	ft.	7.70	13.75	15.50
Onaway	3"	28	.....	.....
Minnesota:				
Lake City	ft.	7	14	17
Stillwater	ft.	¾"-4.352	9.62	.....
.....	ft.	¾"-6.313	11.87	.....
.....	ft.	1"-7.854	17.06	.....
Mississippi:				
Jackson	ft.	4	7.85	8.35
New York:				
Ogdensburg	ft.	6-8.5	¾"-16.35; 1"-15.35	.....
North Carolina:				
Charlotte	ft.	4.5-5	12	16
Raleigh	ft.	1"-5.3; ¾"-3.8	1"-10; ¾"-8.5	1"-12.96; ¾"-8.75
Ohio:				
Newark	ft.	5	.....	7.77
Van Wert	¾" ft.	6.25	7.22	7.44
Wilmington	4" as basis ft.	26.87	65.56	63.38
Oregon:				
Eugene	4" pipe ft. dipped & wrapped	30.08	.....	106.75
Portland	2" ft.	10.93	28.44	.....
Pennsylvania:				
Clearfield	ft.	6	10	12
Indiana	ft.	.35	14.37	1"-15.75
Tennessee:				
Murfreesboro	ft.	½"-4; 1"-7	½"-6.75; 1"-9	½"-7; 1"-10
Texas:				
Taylor	2" 10,000 ft.	16½	.....	.....
Virginia:				
Charlottesville	ft.	½"-2"-8	11	15
Wisconsin:				
Fond du Lac	ft.	6.66 2-3	12	12.25
Wyoming:				
Green River & Rock Springs.	ft.	72	1.41	.....

years, the average was obtained for each year as a means for determining the average increase in cost. This method showed an increase of 81 per cent between 1914 and 1919 and 111 per cent between 1914 and 1920. In other words, the cost of coal to the water works pumping plants has increased nearly half as much during the last few months as the total increase during the five years previous.

Those using electricity for power have been more fortunate. The increase in cost of electric current for pumping plants has not been nearly as great as of coal, and in some cases the price is even less this year than it was six years ago. About forty per cent of the cities report no change in the price paid for current since 1914. On the other hand, those using oil for fuel have had to pay a much greater increase than users of coal. The least increase reported was

37 per cent, while the highest is 400 per cent, and the average per cent increase has been 230 per cent.

In the matter of lime for purification plants, the increase has varied from 5 per cent to 300 per cent, the average increase being 93 per cent. Of the four cities reporting price on soda ash, one reports a 40 per cent decrease in price, another 27 per cent decrease, the third 33 1-3 per cent increase, and the fourth 150 per cent increase.

It appears from the above that material for new construction costs on the average at least 2½ times as much as it did six years ago, although the meters show an increase of less than 50 per cent. For pumping plants, coal is the large item and the price of this is approximately double what it was. It

would seem that water works departments and companies would be justified in increasing their rates to meet these increased costs. The total cost to be met by the rates includes, of course, not only materials and salaries, but also interest and depreciation on the plant, and this might be estimated as showing no increase; although, if it should be necessary to replace any parts of the plant before prices fall to previous levels, this would make a demand on the depreciation account 50 to 100 per cent larger than was provided for. We have received figures from the several superintendents showing to what extent they have increased their water rates during the past twelve months, which figures we are expecting to publish next week. The increases which were made by them up to a year ago were given in our annual water works summary of June 7 last year.

PRICES PAID FOR CAST IRON PIPE. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Average price per ton paid in—		
	1914	1919	1920
Alabama:			
Gadsden	\$20.00	\$45.75	.....
Mobile	25.75	67.00	\$75.00
California:			
Palo Alto	34.00	91.20	97.50
San Francisco..	28.00-26.00	83.20-69.55	94.55-84.55
Colorado:			
Boulder .....	.....	77.00	84.00
Colorado Spgs..	32.00	.....	68.00
Delta .....	.....	.....	97.50
Connecticut:			
Putnam	23.75	59.50	.....
Southington ...	24.85	50.90	80.00
Winsted	22.50	.....	.....
Delaware:			
Lewes	30.50	36.00	.....
Wilmington ...	20.50	57.10	65.00
Florida:			
Pensacola	25.00	56.00	.....
Georgia:			
Albany .....	.....	.....	.....
Cedartown	20.00	55.00	55.00
Thomasville ...	21.95	55.00	.....
Idaho:			
Weiser	45.00	.....	.....
Illinois:			
Mattoon	22.00	67.00	70.00
Monmouth	32.15	.....	.....
Quincy	23.00	51.20	67.00
Rock Island	25.00	58.00	.....
Waukegan	23.00	60.00	80.00
Indiana:			
Columbia City..	23.50	54.60	61.10
Evansville	21.75	55.00	63.50
Garrett .....	.....	59.80	78.00
Kendallville ...	33.15-30.15	.....	77.70-80.80
La Porte	23.25	51.80	69.80
N. Manchester..	26.00	72.50	.....
Richmond	24.35	.....	.....
Terre Haute ...	22.25	50.00	77.80
Iowa:			
Algona	27.50	.....	.....
Cherokee	32.00-25.76	62.60-59.60	.....
Sioux City	23.25	65.25	79.60
Kansas:			
Council Grove..	.....	65.00	.....
Emporia	31.20	70.70	70.50
Fort Scott	35.00	75.00	65.00
Kentucky:			
Providence	19.00	63.00	.....
Louisiana:			
New Iberia.....	24.00	.....	73.00
Maine:			
Lisbon Falls...	43.50	.....	.....
South Paris....	25.90	.....	86.00-90.00
Maryland:			
Hagerstown ...	22.50	62.00	60.00
Massachusetts:			
Athol	22.50	74.00	74.40
Mansfield	21.60	.....	70.00
Maynard .....	.....	64.00	.....
Millbury	27.01	75.00	.....
New Bedford ...	21.75-22.25	46.00	64.00-71.00
Somerville	22.70	57.00	.....
Springfield ...	21.65	.....	63.00-70.00
Winthrop	22.90	70.00	80.00
Woburn	23.00	70.00	.....
Worcester	21.20	.....	.....
Michigan:			
Battle Creek...	22.35	57.80	72.80
Belding	25.00	.....	.....
Crystal Falls...	30.50	.....	69.75
Highland Park..	22.00	56.00	.....
Lansing	23.25	51.80	51.80

PRICES PAID FOR CAST IRON PIPE. AVERAGES FOR 1914, 1919 AND 1920 (Continued).

City and State	Average price per ton paid in—		
	1914	1919	1920
Ludington	\$23.00	\$54.00	\$73.90
Manistique	25.00	54.70	84.00
Onaway	32.00	.....	.....
Saginaw	23.70	51.75	73.40
Minnesota:			
Lake City.....	28.50	68.00	66.00
Rochester	23.30	56.00	76.30
Stillwater	24.40	59.30	.....
Mississippi:			
Greenwood ....	.....	50.00	70.00
Jackson	24.85	62.50	72.00
Missouri:			
Chillicothe	24.50	85.00	80.00
Montana:			
Havre .....	.....	72.30	83.62
Nebraska:			
Hastings	38.00	62.00	73.00
New Jersey:			
Bridgeton	29.00	65.00	72.00
Hawthorne	22.00	.....	.....
New York:			
Albany	21.00	55.50	89.50
Norwich	23.40	74.50	74.50
Ogdensburg ...	23.00	59.00	76.00
Potsdam	26.50	56.00-80.00	.....
Syracuse	25.40	51.40	73.00
Watervliet ....	.....	56.00	.....
Wellsville	30.00	.....	.....
North Carolina:			
Charlotte	22.50	62.50	.....
Henderson	24.00	56.00	74.00
Raleigh	22.00	55.90	69.30
Ohio:			
Barnesville ...	35.00	65.00	80.00
Coshocton	23.00	.....	68.00
Delaware	28.00	42.00	67.00
Lakewood	22.50	67.00	77.00
Martins Ferry..	.....	53.60	94.05
Newark	24.00	72.00	.....
Niles	22.00	66.80	72.80
Van Wert.....	.....	65.00	.....
Wilmington ...	30.00	78.00	110.00
Oklahoma:			
Perry	43.00	65.00	80.00
Sapulpa .....	.....	64.00	.....
Oregon:			
Portland	30.20	70.35	87.63
Pennsylvania:			
Clearfield	20.50	67.50	.....
Indiana	23.90	60.90	67.50
Reading	20.50	50.34	.....
Sewickley	21.50	52.10	77.10
Stroudsburg ...	21.00	56.00	72.00
Tennessee:			
Dyersburg	27.00	55.00	65.00
Murfreesboro ..	43.00	65.00	.....
Texas:			
McKinney	30.00	.....	73.00
Stamford	24.00	.....	57.25
Taylor	26.00	58.00	.....
Temple	26.50	.....	.....
Waco	26.50	65.00	70.00
Virginia:			
Charlottesville..	30.00-34.00	66.00	75.00
Richmond	22.00	57.58	74.46-80.40
Washington:			
Auburn .....	.....	73.80	.....
Spokane	42.50	76.30	87.00
Wisconsin:			
Fond du Lac...	24.80	51.00	51.00
Janesville .....	.....	53.40	64.40
Oconomowoc ..	23.55	.....	.....
Wyoming:			
Cheyenne .....	.....	70.00	90.00
Green River and	.....	.....	.....
Rock Springs..	34.32	68.00	.....

PRICES PAID FOR SPECIAL CASTINGS. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Average price per ton paid in—		
	1914 Cents	1919 Cents	1920 Cents
Alabama:			
Gadsden	4.0	10.0	.....
Mobile	2.75	.....	7
California:			
Palo Alto	4.125	.....	7.75
San Francisco...	3.5	8.0	9.95
Colorado:			
Boulder .....	.....	6.0	7.5
Colorado Springs	2.75	.....	7.25
Delta .....	.....	10.0	.....
Connecticut:			
Putnam	4.0	5.0	.....
Southington	2.75	5.5	.....
Winsted	4.0	.....	.....
Delaware:			
Wilmington	2.7	6.0	10.0
Florida:			
Pensacola	5.5	10.0	10.0
Georgia:			
Thomasville	2.6	5.5	.....
Idaho:			
Lewiston	3.0	5.0	5.0
Weiser	6.0	.....	.....

PRICES PAID FOR SPECIAL CASTINGS. AVERAGES FOR 1914, 1919 AND 1920 (Continued).

City and State	Average Price Paid In—		
	1914 Cents	1919 Cents	1920 Cents
Illinois:			
Mattoon	2.75	6.0	....
Monmouth	4.25	....	....
Quincy	2.75	5.375	6.85
Rock Island	2.5	6.0	....
Waukegan	3.0	5.0	7.0
Indiana:			
Columbus City	3.5	6.5	7.5
Evansville	2.75	5.0	7.5
Garrett .....	....	5.75	7.4
Kendallville	2.5	5.5	7.34-7.84
La Porte	2.75	5.84	6.59
Richmond	2.75	....	....
Terra Haute	2.75	5-5.5	7.39
Iowa:			
Algona	3.5	....	....
Cherokee	2.75	5.9	....
Sioux City	4.5	6.75	7.25
Kansas:			
Council Grove .....	....	5.9	....
Emporia	3.0	7.0	7.5
Maryland:			
Hagerstown	3.0	9.0	9.0
Massachusetts:			
Athol	4.0	8.0	8.5
New Bedford	2.75	5.75	7.25
Somerville	4.67	13.73	14.51
Springfield .....	....	5.5	....
Winthrop	3.5	....	....
Woburn .....	....	20.75	22.825
Worcester	3.0	8-10	10-15
Michigan:			
Battle Creek	2.45	5.5	6.8
Belding	2.75	....	....
Highland Park	2.65	8.0	....
Manistique	3.0	....	7.0
Lansing	2.75	6.0	6.0
Ludington	2.5	6.0	8.0
Saginaw	2.75	5.5	7.0
Minnesota:			
Lake City	4.0	9.0	9.5
Rochester	3.0	5.0	6.0
Stillwater	2.75	5.25	....
Mississippi:			
Jackson	2.75	4.75	5.75
Montana:			
Havre .....	....	5.25	6.25
Nebraska:			
Hastings	4.0	7.0	8.0
New Jersey:			
Bridgeton	4.5	5.0	7.5
New Mexico:			
Roswell .....	....	7.0	7.0
New York:			
Albany	2.5	....	....
Norwich	3.0	....	....
Ogdensburg	2.75	6.0	7.5
Potsdam	3.5	5.75	....
Syracuse	2.5	5.5	10.0
Watervliet .....	....	5.5	....
Wellsville	2.75	....	....
North Carolina:			
Charlotte	2.5	5.75	8.5
Raleigh	2.75	3.5	6.5
Ohio:			
Barnesville	4.0	6.0	8.0
Delaware	2.9	....	6.55
Lakewood	2.75	....	8.75
Martins Ferry .....	....	4.89	....
Newark	2.75	....	....
Niles	2.75	6.0	6.59
Van Wert .....	....	5.875	....
Oklahoma:			
Perry	3.0	4.5	8.0
Oregon:			
Portland	2.38	....	8.0
Pennsylvania:			
Clearfield	2.75	....	....
Indiana	14.0	7.0	....
Reading	2.5	5.75	....
Sewickley	3.5	5.0	6.25
Stoudsburg	2.5	6.5	7.5
Tennessee:			
Dyersburg	3.0	4.5	4.5
Murfreesboro	5.0	7.0	....
Texas:			
McKinney .....	....	5.5	6.7
Taylor	3.0	....	....
Waco	2.0	4.0	5.5
Virginia:			
Charlottesville	3.5	5.5	6.5
Richmond	2.5	6.0	7.5
Washington:			
Auburn .....	....	5.0	....
Spokane	4.0	8.5	8.5
Wisconsin:			
Fond du Lac	2.75	5.25	5.25
Janesville .....	....	5.5	7.42
Wyoming:			
Green River & } Rock Springs }	4.4	6.6	9.5

PRICES PAID FOR LEAD. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Average Price Per Pound Paid In—		
	1914 Cents	1919 Cents	1920 Cents
Alabama:			
Gadsden	3.78	7.50	....
Mobile	4.55	....	....
California:			
Palo Alto	4.70	9.00	8.10
San Francisco	4.93	6.09	8.31
Colorado:			
Boulder .....	....	9.00	12.00
Colorado Springs	7.20	....	10.00
Delta .....	....	8.00	....
Connecticut:			
Putnam	5.80	8.75	....
Southington	4.50	6.50	10.00
Winsted	4.60	....	....
Delaware:			
Lewes	6.00	20.00	19.00
Wilmington	5.50	9.00	9.00
Florida:			
Pensacola	5-5.50	10.00	....
Georgia:			
Albany .....	....	....	9.00
Cedartown	5.00	11.00	....
Thomasville	4.94	7.00	....
Idaho:			
Lewiston	5.50	....	8.20
Weiser	7.00	....	....
Illinois:			
Mattoon	3.20	7.80	9.00
Monmouth	9.00	10.50	11.75
Quincy	4.05	5.40-6.12	....
Rochelle .....	....	....	11.75
Rock Island	4.00	7.50	....
Waukegan	5.00	8.00	11.00
Indiana:			
Columbus City	4.00	5.375	8.50
Evansville	4.50	5.00	5.50
Kendallville	8.00	8.75	9.75
La Porte	5.00	12.00	11.50
North Manchester	2.75	8.50-14	....
Terre Haute	4.07	5.85	9.00
Union City	5.00	10.00	....
Iowa:			
Algona	7.50	9.00	....
Cherokee	4.75	5.25	....
Sioux City	3.50	11.00	11.00
Kansas:			
Council Grove .....	....	7.00	....
Emporia .....	....	11.00	11.25
Fredonia	5.50	8.50	....
Fort Scott	3.50	....	10.50
Kentucky:			
Providence	4.00	12.00	....
Louisiana:			
New Iberia	4.75	....	12.00
Maine:			
South Paris .....	....	....	12.00
Maryland:			
Hagerstown	5.50	11.00	9.00
Massachusetts:			
Athol	4.25	6.45	....
New Bedford	4.225	6.30	....
Somerville	4.19	5.60-7.15	....
Springfield	3.84-4.225	5.58	7.65
Winthrop	4.24	8.95	10.50
Woburn .....	....	6.60	9.95
Worcester	23.85	8.00	8.00
Michigan:			
Battle Creek	4.17	5.75	9.75
Belding	4.95	.07*	....
Crystal Falls	5.00	....	14.00
Highland Park	3.80	9.50	....
Lansing	4.50	7.80	9.59
Ludington	4.50	....	11.00
Manistique	5.00	....	....
Onaway	6.00	....	....
Saginaw	5.00	7.00	10.00
Minnesota:			
Hutchinson .....	....	....	10.75
Lake City	7.00	9.00	12.00
Rochester	6.00	9.00	12.00
Stillwater	4.65	7.50	....
Mississippi:			
Greenwood .....	....	....	10.00
Jackson	4.50	8.50	12.00
Montana:			
Havre .....	....	7.50	9.75
Nebraska:			
Hastings	6.00	10.00	11.00
New Jersey:			
Bridgeton	4.50	7.00	10.00
Hawthorne	6.00	....	....
New Mexico:			
Roswell .....	....	10.00	11.75

PRICES PAID FOR LEAD. AVERAGES FOR 1914, 1919 AND 1920 (Continued)

City and State	Average Price Per Pound Paid In—		
	1914 Cents	1919 Cents	1920 Cents
New York:			
Albany	4.35	.....	9.20
Norwich	5.50	6.66 2-3	.....
Ogdensburg	5.00	5.70	10.00
Potsdam	6.00	7.50	.....
Syracuse	4.85	6.00	10.00
Watervliet	5.00	.....	.....
Wellsville	6.75	.....	.....
North Carolina:			
Charlotte	7.90	9.00	10.00
Henderson	5.20	7.50	14.00
Raleigh	4.75	10.00	10.00
Ohio:			
Barnesville	4.00	6.00	12.00
Coshocton	4.00	.....	10.00
Delaware	4.65	7.65	9.00
Lakewood	7.25	8.50	10.00
Newark	4.25-5.00	8.00	10.75
Niles	4.95	7.00	11.50
Toronto	5.00	15.00	.....
Van Wert .....	.....	6.25	12.00
Wilmington	5.00	6.50	10.50
Oregon:			
Portland	4.19	.....	.....
Pennsylvania:			
Clearfield	3.90	6.25	.....
Sewickley	6.00	9.00	9.75
Sharpsville	5.25	7.50	.....
Tennessee:			
Dyersburg	6.00	8.00	8.00
Murfreesboro	3.50	7.00	9.00
Texas:			
McKinney	5.00	.....	8.00
Temple	6.00	.....	.....
Waco .....	.....	10.00	12.00
Virginia:			
Charlottesville	5.50	9.00	10.75
Richmond	4.50	9.00	9.21
Washington:			
Auburn .....	.....	.....	10.00
Spokane .....	.....	6.5357	.....
Wisconsin:			
Fond du Lac	4.05	5.75	9.40
Janesville .....	.....	6.50	9.75
Wyoming:			
Cheyenne .....	.....	7.00	12.00
Green River & } Rock Spring }	5.00	.....	.....

*Scrap lead.

PRICES PAID FOR METERS, ¾ INCH. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Average Price Paid In—		
	1914	1919	1920
Alabama:			
Gadsden	\$12.00	\$20.00	.....
Mobile	6.00	9.95	\$11.75
Palo Alto	8.60	11.97	11.97
San Francisco .....	.....	18.00	19.50
Colorado:			
Colorado Springs ...	22.00	.....	36.00
Connecticut:			
Southington	12.00	16.20	19.50
Winsted	10.00	.....	.....
Delaware:			
Lewes	7.00	9.00	10.00
Wilmington	7.95	16.20	16.20
Florida:			
Pensacola	6.40	9.50	.....
Georgia:			
Albany .....	.....	.....	9.50
Cedartown*	8.40	10.80	12.00
Thomasville†	7.74	11.61	11.61
Valdosta .....	.....	10.00	10.00
Idaho:			
Lewiston†	8.00	12.00	12.85
Weiser	8.50	.....	11.20
Illinois:			
Bushnell	11.50	9.50	.....
Chicago Hgts†	8.40	8.40	.....
Mattoon	8.00	11.00	11.00
Monmouth*	9.50	10.50	12.97
Quincy	10.71	.....	15.10
Rochelle .....	.....	.....	10.39 ½
Rock Island	9.00	12.00	.....
Sparta .....	.....	9.75	.....
Waukegan*	8.00-10.00	10.75	13.00
Indiana:			
Columbia City	12.60	18.75	19.50
Delphi*	7.00	12.00	13.00
Evansville	7.55	12.25	.....
Garrett .....	.....	8.80	10.00
Kendallville*	7.00	10.50	.....
Lebanon	8.40	10.50	10.50
No. Manchester	7.85	12.10	16.00
Richmond*	8.00	.....	.....
Shelbyville	9.50	15.00	.....
Terre Haute	15.00	18.00	20.40

PRICES PAID FOR METERS, ¾ INCH. AVERAGES FOR 1914, 1919 AND 1920 (Continued).

City and State	Average Price Paid In—		
	1914	1919	1920
Iowa:			
Algona	\$7.00	\$8.00	\$8.50
Cherokee* .....	.....	11.34	11.34
Sioux City	12.50	17.75	.....
Kansas:			
Council Grove .....	.....	11.50	11.50
Fredonia*	10.00	11.64	11.80
Fort Scott*	10.00	.....	14.00
Kentucky:			
Providence	12.00	14.50	.....
Louisiana:			
New Iberia	8.25	.....	11.50
Maryland:			
Hagerstown	11.75	18.00	19.50
Massachusetts:			
Lenox	11.85	12.50	.....
Mansfield*	8.40	.....	19.395
Millbury*	8.40	10.00	.....
New Bedford	7.95	.....	18.00
Somerville	9.80	14.25	.....
Springfield	12.00	.....	.....
Winthrop	12.60	14.17	.....
Woburn	12.00	14.25	13.80
Worcester	12.00	15.00	16.00
Michigan:			
Battle Creek	12.00	15.00	15.75
Belding* .....	.....	12.60	.....
Charlotte	6.35	9.00	9.50
Highland Park	12.00	14.25	.....
Lansing	12.60	.....	.....
Onaway	12.80	.....	.....
Minnesota:			
Cloquet	8.60	12.60	.....
Hutchinson	8.00	10.00	13.00
Lake City*	14.00	15.00	16.00
Rochester	12.80	12.80	23.40
St. Peter .....	.....	8.75	8.75
Mississippi:			
Canton† .....	.....	10.75	10.75
Jackson	16.00	17.50	20.00
Montana:			
Havre .....	.....	16.20	6.20
Nebraska:			
Hastings	12.50	15.60	15.85
New Jersey:			
Hawthorne	6.25	.....	.....
New Mexico:			
Roswell*	10.80	10.80	11.60
New York:			
Albany	11.34	.....	.....
Norwich*	7.30	.....	10.75
Ogdensburg	12.00	.....	.....
Watervliet .....	.....	10.20	10.20
Wellsville	8.40	10.70	10.70
North Carolina:			
Charlotte*	6.50	10.21	10.50
Henderson	7.35	11.00	11.00
Raleigh	13.50	15.00	19.50
Ohio:			
Barnesville	8.25	14.00	15.25
Coshocton	8.40	.....	12.60
Delaware*	7.00	10.80	.....
Lakewood*	7.00	10.71	10.71
Newark	12.60	.....	.....
Niles	12.00	.....	18.90
Van Wert	7.50	10.00	.....
Wilmington* .....	.....	10.00	11.00
Oklahoma:			
Perry	12.40	14.60	.....
Oregon:			
Eugene .....	.....	.....	10.00-13.00
Portland	10.00	.....	.....
Pennsylvania:			
Clearfield	15.00	18.00	18.00
Indiana	13.50	13.50	13.50
Reading	11.34	.....	13.00
Sewickley	15.00	24.00	26.00
Sharpsville	7.50	11.00	.....
Tennessee:			
Dyersburg	9.60	10.50	12.00
Murfreesboro*	6.40	12.00	14.50
Texas:			
Georgetown	11.35	15.00	17.00
Stamford	22.00	.....	32.00
Taylor	10.50	16.50	.....
Temple†	11.60	12.00	14.50
Waco	10.60	18.00	19.80
Virginia:			
Charlottesville†	9.50-11.50	17.00-11.00	12.00-14.00
Richmond	8.25	12.40	14.25
Washington:			
Auburn	?	10.61	.....
Chehalis	12.00	18.00	22.00
Wisconsin:			
Fond du Lac*	6.20	10.39	10.40
Janesville .....	.....	13.50	14.85
Oconomowoc	8.40	12.60	12.60
Wyoming:			
Green River } and Rock Springs† }	8.00	.....	12.60

*—¾-inch meters. †—½ and ¾-inch. ‡—½ and 1-inch. §—¾-inch.

PRICES PAID FOR VALVES, 6 INCH. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Average Price Paid In—		
	1914	1919	1920
Alabama:			
Gadsden	\$14.00	\$37.50	.....
California:			
Palo Alto	8.72	25.25	\$27.85
San Francisco .....	.....	.....	.....
Colorado:			
Boulder .....	.....	23.95	.....
Colorado Springs	13.00	.....	17.50
Connecticut:			
Putnam	7.80	23.73	18.25
Southington	10.00	23.10	25.00
Delaware:			
Lewes	16.00	28.00	.....
Wilmington	7.95	16.20	16.20
Florida:			
Pensacola	9.00	25.00	.....
Georgia:			
Thomasville	7.69	16.61	.....
Idaho:			
Lewiston	11.85-13.90	23.40-27.75	32.00
Weiser	11.60	.....	.....
Illinois:			
Quincy	11.65	21.78	23.95
Rochelle† .....	.....	.....	15.20
Rock Island	16.00	21.00	.....
Waukegan	12.00	23.00	30.00
Indiana:			
Columbia City.....	.....	26.35	.....
Delphi*	7.00	12.00	13.00
Evansville	11.00	.....	.....
Garrett .....	.....	20.00	25.00
Kendallville	13.00	22.00	25.00
La Porte	12.80	20.75	22.85
Richmond	12.00	.....	.....
Terre Haute	11.75	20.80	.....
Iowa:			
Cherokee	10.00	11.90	.....
Sioux City	10.25	14.00	21.95
Kansas:			
Emporia	10.70	24.20	.....
Louisiana:			
New Iberia	7.50	.....	18.00
Maine:			
South Paris‡ .....	.....	.....	37.80
Maryland:			
Hagerstown	13.80	24.25	.....
Massachusetts:			
Athol	13.50	.....	22.75
Milbury	18.20	.....	.....
New Bedford	10.50	21.83	24.00
Somerville	10.50	20.79	22.85
Springfield	13.00	36.40	26.00
Winthrop	11.95	20.79	25.00
Woburn	11.00	17.65	.....
Worcester	9.00	16.00	22.00
Michigan:			
Battle Creek.....	11.50	21.80	25.00
Belding	7.00	11.40	.....
Crystal Falls.....	9.85	.....	23.50
Highland Park	10.50	22.00	25.00
Lansing	10.00	19.97	.....
Ludington	10.52	20.00	.....
Manistique	18.00	23.70	27.70
Saginaw	10.50	20.80	25.00
Minnesota:			
Lake City	23.00	38.00	40.00
Rochester	15.00	.....	26.00
Stillwater	12.60	21.78	.....
Mississippi:			
Jackson	12.00	22.50	27.00
Montana:			
Havre .....	.....	23.78	27.00
Nebraska:			
Hastings	16.25	22.00	28.75
New York:			
Albany	11.00	20.80	.....
Norwich	11.00	23.12	.....
Ogdensburg	12.50	20.79	25.00
Potsdam	18.00	.....	.....
Syracuse	12.50	21.30	27.50
Wellsville	10.50	.....	.....
North Carolina:			
Charlotte	8.00	19.50	21.50
Raleigh	11.20	24.20	24.00
Ohio:			
Barnesville	6.50	12.25	14.50
Delaware	16.20	.....	20.25
Lakewood	9.21	18.75	20.75
Martin's Ferry .....	.....	32.50	.....
Niles†	27.00	.....	.....
Van Wert .....	.....	32.50	.....
Oklahoma:			
Perry	28.00	51.00	.....
Oregon:			
Eugene† .....	.....	.....	20.00
Portland	7.55	.....	23.50
Pennsylvania:			
Clearfield	11.00	.....	.....
Indiana	12.50	23.10	.....
Reading	7.50	20.80	25.00
Sewickley	12.60	20.00	24.00
Stroudsburg	11.00	.....	26.00

City and State	Average Price Paid In—		
	1914	1919	1920
Tennessee:			
Dyersburg	10.00	12.00	14.00
Murfreesboro	14.00	.....	.....
Texas:			
McKinney .....	.....	.....	28.00
Taylor	9.50	17.50	.....
Waco	10.80	22.77	25.00
Virginia:			
Richmond	7.50	20.79	25.00
Washington:			
Auburn .....	.....	20.47	.....
Spokane	14.00	26.31	29.45
Wisconsin:			
Fond du Lac.....	8.12	23.72	23.96

*—½-inch. †—4-inch. ‡—8-inch. §—10-inch.

PRICES PAID FOR HYDRANTS, 2-WAY AND STEAMER. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Average Price Paid In—		
	1914	1919	1920
Alabama:			
Gadsden	\$22.50	\$46.00	.....
Mobile	28.50	.....	\$53.00
California:			
Palo Alto	26.50	52.00	56.00
Colorado:			
Colorado Springs* ..	58.00	.....	70.50
Connecticut:			
Putnam .....	.....	45.00	.....
Southington†	24.50	54.00	54.50
Winsted	27.00	50.00	.....
Delaware:			
Lewes	25.00	42.00	.....
Wilmington	29.50	53.41	.....
Florida:			
Pensacola	25.00	54.00	.....
Georgia:			
Cedartown ‡	24.00	45.00	.....
Thomasville	23.95	50.03	.....
Idaho:			
Lewiston‡	35.00	47.50	58.85
Weiser	52.26	.....	.....
Illinois:			
Mattoon	22.00	57.00	.....
Monmouth	56.00	76.00	.....
Quincy	36.00	65.25	66.75
Rochelle§ .....	.....	.....	52.00
Rock Island	48.00	75.00	.....
Waukegan	40.00	70.00	105.00
Indiana:			
Columbia City.....	27.50	45.00	57.00
Delphi	28.50	.....	.....
Evansville†	31.00	54.50	63.25
Garrett .....	.....	35.00	54.50
Kendallville	26.50	54.00	54.00
La Porte	28.00	43.40	51.40
Lebanon	35.00	.....	.....
North Manchester ..	31.00	39.80	.....
Richmond	27.50	.....	.....
Terre Haute	33.35	57.90	.....
Union City	37.50	50.00	.....
Iowa:			
Cherokee	33.00	49.25	.....
Sioux City	39.00	73.50	.....
Kansas:			
Emporia	22.95	42.00	.....
Louisiana:			
New Iberia	27.00	.....	38.00
Maryland:			
Hagerstown	27.00	.....	.....
Massachusetts:			
Cherry Valley †	30.00	45.00	.....
and Rochdale ‡ .....	.....	.....	.....
Milbury	25.00	.....	54.50
New Bedford	31.95	54.84	59.40
Somerville	30.00	66.65	66.65
Springfield**	27.00 & 33.78	57.87	63.70
Winthrop	28.25	59.00	71.00
Woburn	27.25	50.75	60.75
Worcester	29.00	57.00	65.00
Michigan:			
Battle Creek.....	32.00	55.15	70.60
Belding	24.00	.....	.....
Crystal Falls.....	32.00	.....	63.00
Highland Park.....	44.25	88.00	.....
Lansing	30.00	62.36	68.05
Ludington	26.00	58.00	.....
Manistique	27.00	.....	56.60
Onoway	28.50	.....	.....
Saginaw††	30.00	62.35	74.80
Minnesota:			
Lake City‡‡	54.00	64.00	70.00
Rochester	27.25	51.70	52.75
Stillwater	28.00	56.96	.....
Mississippi:			
Greenwood .....	.....	45.00	.....
Jackson	36.00	65.00	68.00
Montana:			
Havre .....	.....	58.72	64.05

PRICES PAID FOR HYDRANTS, 2-WAY AND STEAMER. AVERAGES FOR 1914, 1919 AND 1920 (Continued).

City and State	Average Price Paid In—		
	1914	1919	1920
Nebraska:			
Hastings	38.75	52.00	66.00
New Jersey:			
Bridgeton	40.00	.....	53.00
New York:			
Albany	30.75	63.65	63.65
Norwich††	50.45	60.30	.....
Ogdensburg	26.50	.....	57.20
Potsdam	24.00	48.00	.....
Syracuse	25.00	51.00	60.25
Watervliet .....	.....	55.00	.....
Wellsville	22.50	.....	.....
North Carolina:			
Charlotte†	21.50	50.25	58.50
Henderson	23.00	.....	45.00
Raleigh	25.00	37.50	59.75
Ohio:			
Barnesville	24.50	48.00	48.00
Coshocton	32.00	.....	52.00
Delaware .....	.....	26.65	48.55
Lakewood	24.70	59.00	58.00
Martins Ferry .....	.....	56.50	.....
Niles	21.00	.....	.....
Van Wert .....	.....	65.00	.....
Wilmington	30.00	39.00	.....
Oklahoma:			
Sapulpa .....	.....	58.00	.....
Oregon:			
Portland	24.90	.....	.....
Pennsylvania:			
Clearfield	22.50	.....	.....
Indiana	24.00	41.65	.....
Reading	29.00	61.10	73.25
Sewickley	25.50	34.00	36.00
Sharpsville	25.00	50.00	.....
Tennessee:			
Dyersburg	20.00	30.00	50.00
Murfreesboro††	27.00	56.00	.....
Texas:			
McKinney .....	.....	.....	55.00
Taylor	21.00	36.50	.....
Temple	36.00	67.50	92.00
Waco	29.50	61.80	67.50
Virginia:			
Charlottesville	27.50	47.50	.....
Richmond	37.50	73.50	78.50
Washington:			
Auburn .....	.....	.....	54.00
Spokane	54.75	102.05	.....
Wisconsin:			
Fond du Lac	24.35	67.50	.....
Janesville .....	.....	54.00	60.00
Oconomowoc	26.50	.....	.....
Wyoming:			
Green River..... {	.....	.....	.....
and Rock Spgs.... {	38.21	64.62	.....

*—With 5-inch valve. †—With 4-inch valve. ‡—4-inch. ††—3-way. **—5-inch and 6-inch. ‡‡—5-inch. ‡‡—2-way only. ‡‡—6-inch.

PRICES PAID FOR COAL. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Average Price per Ton Paid In—		
	1914	1919	1920
Alabama:			
Gadsden	\$2.25	.....	.....
Mobile	2.95	\$6.15	.....
Colorado:			
Boulder .....	.....	7.50	\$7.00
Delta	6.00	7.75	8.25
Connecticut:			
Putnam	5.75	9.75	.....
Delaware:			
Lewes	2.45	1.15	3.25
Wilmington	3.22	6.90	8.25
Florida:			
Pensacola	2.55	4.60	5.20
Georgia:			
Albany	1.50	3.00-3.50	4.00-5.50
Cedartown	1.10	3.60	5.25
Thomasville	3.25	6.26	6.83
Valdosta	3.30	6.00	8.40
Illinois:			
Chicago Heights	2.19	4.10	4.50
Du Quoin .....	.85	2.45	2.95
Mattoon	1.75	3.25	3.80
Monmouth	2.58	4.17	5.47
Quincy †	1.41	3.50	3.75
Rochelle .....	.....	.....	4.32
Rock Island	1.45	3.40	.....
Waukegan	2.00	4.00	5.00
Indiana:			
Columbus City	1.25	2.40	4.15
Delphi	2.25	4.75	.....
Evansville *	1.00	2.80	3.15
Garrett .....	.....	2.20	2.45

PRICES PAID FOR COAL. AVERAGES FOR 1914, 1919 AND 1920 (Continued).

City and State	Average Price Paid In—		
	1914	1919	1920
Indiana (continued):			
Kendallville	2.85	5.06	5.59
La Porte	2.75	5.45	6.50
Lebanon	1.90	2.35	3.00
North Manchester ..	2.25-2.60	6.50	8.00
Richmond .....	.85	.....	.....
Shelbyville	1.15	2.00	2.65
Terre Haute	1.00	2.71	3.36
Union City	2.86	4.34	4.95
Iowa:			
Algona	6.00	7.50	10.00
Atlantic	1.80	3.90	4.00
Cherokee	2.00	.....	.....
Denison	2.75	.....	5.10
Maquoketa	4.00	5.50	6.10
Sioux City	3.25	6.90	6.90
Kansas:			
Council Grove .....	.....	6.00	6.00
Fort Scott *	1.10	2.80	3.10
Kentucky:			
Providence	1.80	2.75	5.30
Louisiana:			
New Iberia	3.20	5.85	5.85
Massachusetts:			
Lenox	7.50	13.00	14.00
Mansfield .....	.....	.....	4.25-4.50
Maynard .....	.....	10.00	13.55
New Bedford	4.18	8.22	.....
Springfield	7.25 L.T.	10.00 N.T.	11.00 N.T.
Woburn	4.86	9.18	.....
Michigan:			
Battle Creek	1.20	2.75	.....
Belding	2.25	.....	.....
Charlotte	1.10	2.15	2.50-4.00
Crystal Falls	4.50	.....	9.75
Highland Park	8.75	10.50	13.00
Lansing	0.60	2.50	2.50
Ludington	4.50	6.20	7.28
Onaway	3.25	8.00	8.50
Saginaw	3.00	4.60	5.50
Minnesota:			
Hutchinson .....	.....	10.00	10.00
Lake City	4.30	8.65	11.00
Rochester	5.00	6.00	8.00
Stillwater	3.65†	8.50-9.50‡	8.50
Mississippi:			
Canton	0.79	2.50	2.90
Greenwood	0.90	3.50	5.00
Jackson	3.45	7.10	7.85
Missouri:			
Chillicothe	1.60	3.05	3.50
Nebraska:			
Hastings	1.60	1.85	2.25
New Jersey:			
Bridgeton	3.40	4.90	5.75
New Mexico:			
Roswell	6.50	6.35	6.35
New York:			
Albany	2.42	5.25	6.25
Norwich	6.65-5.65	9.45-8.10	9.95-8.80
Ogdensburg	5.25	11.00	12.50
Potsdam	6.00	8.50	.....
Wellsville	2.00	4.20	4.55
North Carolina:			
Charlotte	3.50	6.50	9.00
Henderson	3.20	5.90	7.90
Raleigh	4.00	6.96	9.00
Ohio:			
Barnesville	8.00	13.40	17.80
Coshocton †	0.12	0.17	0.21
Delaware	0.95	2.25	4.25
Newark	1.60	2.70	4.65
Niles	2.00	3.30	.....
Van Wert	1.75	2.50	4.25
Wilmington	0.65	2.20	4.25
Oklahoma:			
Perry	1.80	4.25	4.25
Sapulpa .....	.....	4.20	.....
Pennsylvania:			
Reading **	2.70	4.50	4.95
Sharpsville	1.75	4.00	4.25
Stroudsburg	2.80	5.87	5.87
Tennessee:			
Dyersburg	1.55	2.75	3.15
Murfreesboro	2.30	5.05	5.60
Texas:			
Georgetown ††	0.75	1.40	1.75
Stamford	3.75	.....	5.40
Taylor	1.22	.....	2.35
Temple ††	1.58	2.58	.....
Waco *	3.15	6.00	7.25
Virginia:			
Charlottesville	2.75	4.50	6.00
Washington:			
Spokane	9.12	11.65	13.75
Wisconsin:			
Fond du Lac	3.00	4.50	2.70
Janesville .....	.....	4.05	4.35
Oconomowoc	4.10	6.23	8.88
Wyoming:			
Green River	1.25	3.57	.....

*—Slack. †—Screenings. ‡—Lump. ††—Per Bushel. **—Bituminous. ‡‡—Lignite.

PRICES PAID FOR ELECTRIC CURRENT FOR POWER. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Average Price Per Kw. H. Paid In— 1914 1919 1920 Cents Cents Cents		
Alabama:			
Gadsden .....	.....	.75	.75
California:			
Palo Alto	2.00	2.00	2.00
Redlands	0.98	1.23	.....
Connecticut:			
Putnam .....	.....	1.775	1.65
Delaware:			
Lewes	10.00	.....	.....
Wilmington	4.00	2.50	2.50
Florida:			
Pensacola .....	.....	2.50	2.50
Georgia:			
Albany .....	.875	.....	.....
Cedartown .....	.....	1.11	1.33
Idaho:			
Lewiston	1.50	1.50	1.50
Weiser	1.50	.....	1.50
Illinois:			
Chicago Heights	2.50	2.50	2.50
Du Quoin	1.20	2.50	2.50
Mattoon	2.25	.....	.....
Quincy .....	.....	.75	.75
Sparta	4.00	.....	.....
Indiana:			
Delphi .....	.....	2.00	3.10
La Porte	1.37	1.78	.....
Lebanon	2.50	2.50	2.50
North Manchester .....	.....	4.202	4.234
Iowa:			
Algona	4.00	4.00	4.00
Cherokee	2.75	2.75	2.75
Denison	3.00	3.00	3.00
Sioux City	2.00	2.50	2.50
Kansas:			
Emporia	2.00	2.25	2.25
Fredonia	2.50	2.50	2.50
Maryland:			
Hagerstown .....	.....	1.50	1.50
Massachusetts:			
Cohasset .....	.....	6.25	.....
Millbury	1.95	2.45+20%	1.95+15%
New Bedford .....	.....	2.156	.....
Springfield	3.00	3.00	3.00
Michigan:			
Battle Creek	1.00-1.33 1-3	1.25	1.25
Highland Park .....	.84	1.04	1.04
Lansing	1.14	1.80	1.80
Onaway	2.00	2.00	2.00
Saginaw .....	.....	.....	1.20
Minnesota:			
Cloquet	2.00	2.00	2.00
Hutchinson	13.00	12.50	12.50
Lake City	8.00	8.00	8.00
Rochester	1.50	1.50	1.50
St. Peter .....	.....	2.00	2.00
Stillwater	1.75	1.75	1.75
Mississippi:			
Jackson	1.50	2.50	2.50
Missouri:			
Chillicothe	2.00	2.50	2.50
Montana:			
Havre	1.16	1.16	1.16
Nebraska:			
Hastings .....	.....	.18	.20
New York:			
Norwich	16.00	16.00	16.00
Potsdam	3.00	.....	.....
Watervliet .....	.....	1.75	1.75
North Carolina:			
Charlotte	1.00	1.00	1.00
Raleigh	1.50	1.5849	1.8587
Ohio:			
Barnesville	2.00	4.00	5.00
Niles .....	.....	1.00	1.00
Wilmington	4.831	3.782	3.41
Oklahoma:			
Perry	3.50	4.20	4.20
Oregon:			
Eugene	1.50	.....	9.00
Pennsylvania:			
Sharpsville	20.00	22.00	.....
South Carolina:			
Newberry	1.50	1.50	.....
Texas:			
Temple	1.60	.....	.....
Wisconsin:			
Oconomowoc	5.00	.....	.....

PRICES PAID FOR FUEL OIL. AVERAGES FOR 1914, 1919 AND 1920.

City and State	Unit	Average Price Paid In— 1914 1919 1920		
Alabama:				
Mobile	bbl.	.....	.....	\$1.15
California:				
Redlands	bbl.	\$0.70	\$2.08	2.33
San Francisco	bbl.	0.80	1.80	1.80
Colorado:				
Delta .....	.....	6.00	7.75	8.25
Connecticut:				
Putnam .....	.....	5.75	9.75	.....
Georgia:				
Albany	gal.	0.025	0.035	0.10
Indiana:				
Shelbyville	gal.	0.01	0.07	0.085
Terre Haute	engine gal.	0.143	0.246	0.29
Iowa:				
Algona .....	.....	0.06	0.08-0.09	0.105
Louisiana:				
New Iberia	bbl.	1.05	1.57	3.75
Maine:				
Lisbon Falls	gal.	.....	0.1225	0.19
Massachusetts:				
Cherry Valley } & Rochdale }	.....	0.04	0.14	.....
Cohasset	gal.	0.05 or 0.06	.....	0.19
New Jersey:				
Hawthorne	gal.	0.045	.....	.....
New Mexico:				
Roswell .....	.....	.....	0.0825	0.1425
New York:				
Syracuse	gal.	0.08	0.10	0.19
Ohio:				
Barnesville	gal.	0.28	0.45	0.48
Oklahoma:				
Perry	bbl.	.....	1.60	3.30
Pennsylvania:				
Stroudsburg	gal.	0.03	0.10	0.15
Texas:				
Stamford	bbl.	0.92	1.15	3.00

PRICES PAID FOR LIME (for purification plants). AVERAGES FOR 1914, 1919 AND 1920.

City and State	Unit	Average Price Paid In— 1914 1919 1920		
Alabama:				
Mobile .....	.....	.....	\$0.025	\$0.025
Georgia:				
Albany	bbl.	\$1.00	1.25	2.00
Illinois:				
Quincy .....	.....	.....	13.25	14.25
Indiana:				
Evansville	ton	8.00	12.70	14.20
Louisiana:				
New Iberia	bbl.	1.25	2.50	2.75
Michigan:				
Ludington	lb.	0.03	0.065	0.035
Mississippi:				
Jackson	ton	7.00	15.00	16.00
Missouri:				
Chillicothe .....	.....	20.00	21.00	21.00
New York:				
Norwich	lb.	0.025	0.04	0.04
North Carolina:				
Charlotte	bbl.	1.00	2.00	2.25
Raleigh	lb.	0.02	0.065	0.0325
Ohio:				
Niles	ton	.....	14.20	16.50
Wilmington	ton	15.00	14.90	17.00
Oklahoma:				
Perry	100 lb.	0.80	1.50	1.50
Pennsylvania:				
Indiana	ton	7.00	10.00	.....
Tennessee:				
Murfreesboro	lb.	0.0225	0.07	0.09
Texas:				
Waco	sack	0.25	0.50	0.55

PRICES PAID FOR SODA ASH (for purification plants). AVERAGES FOR 1914, 1919 AND 1920.

City and State	Average Price Per Pound Paid In— 1914 1919 1920		
Georgia:			
Valdosta .....	.....	.....	\$0.0375
New Jersey:			
Bridgeton	\$0.015	\$0.0285	0.0375
New Mexico:			
Roswell	0.055	0.04	0.04
North Carolina:			
Raleigh	0.025	0.035	0.033 1-3
Ohio:			
Wilmington	0.045	0.02	0.028
Pennsylvania:			
Indiana	0.00875	0.04	.....

NEWS OF THE SOCIETIES

June 16-17.—LEAGUE OF MINNESOTA MUNICIPALITIES. Annual convention, Bemidj, Minn. Executive Secretary, E. L. Bennett, University of Minnesota, Minneapolis, Minn.

June 16-18.—NORTH CAROLINA GOOD ROADS ASSOCIATION. Annual convention, Asheville, N. C.

June 19-21.—TRI-STATE WATER AND LIGHT ASSOCIATION. Tenth annual convention, Atlanta, Ga. Secretary-treasurer, W. F. Steiglitz, Columbia, S. C.

June 21-23.—CANADIAN PUBLIC HEALTH ASSOCIATION. Annual meeting, Vancouver, B. C. General Secretary, R. D. Defries, M. D., Toronto, Ont.

June 21-25.—AMERICAN WATER WORKS ASSOCIATION. Annual meeting, Montreal, Canada. Secretary, John M. Diven, 153 West 71st Street, New York City.

June 21-25.—INTERNATIONAL ASSOCIATION OF ROTARY CLUBS. Annual convention, Atlantic City, N. J. Secretary, Chesley R. Perry, 910 South Michigan avenue, Chicago, Ill.

June 22.—JOINT COMMITTEE ON STANDARD SPECIFICATIONS FOR CONCRETE AND REINFORCED CONCRETE. Next meeting at Asbury Park. Secretary-Treasurer, D. A. Abrams, Lewis Institute, Chicago.

June 22-25.—AMERICAN SOCIETY FOR TESTING MATERIALS. Asbury Park, N. J. Office of secretary, Philadelphia.

June 29-July 2.—AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Annual convention. Secretary, F. L. Hutchinson, 33 West 39th street, New York.

July 6-8.—CONFERENCE OF MAYORS AND OTHER CITY OFFICIALS OF THE STATE OF NEW YORK. Annual conference, Jamestown, N. Y. Secretary, William P. Capes, 25 Washington avenue, Albany, N. Y.

July 26-30.—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Annual convention, Toronto, Canada. Secretary, Stephen E. Hoey, Municipal Building, New York.

Aug. 30-Sept. 3.—AMERICAN PUBLIC HEALTH ASSOCIATION. San Francisco. Office of secretary, Boston.

Sept. 7-10.—NEW ENGLAND WATER WORKS ASSOCIATION. Annual convention, Holyoke, Mass. Secretary, Frank J. Gifford, 715 Tremont Temple, Boston, Mass.

Sept. 13-17.—AMERICAN PUBLIC HEALTH ASSOCIATION. Boston, Massachusetts.

Sept. 13-17.—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual convention, San Francisco, Cal.

Sept. 13-17.—SOUTHWESTERN WATER WORKS ASSOCIATION. Annual convention, St. Charles Hotel, New Orleans, La. Secretary, E. L. Fulkerson, Waco, Texas.

Oct. 12-14.—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention, St. Louis, Mo. Secretary, Charles Carroll Brown, 401 Lincoln Avenue, Valparaiso, Ind.

Engineering Federation.

That the proposed organizing conference that met in Washington, D. C., June 3 and 4 to consider a plan for engineering federation will exert an important influence is assured by the appointment of delegates from about fifty of the most prominent engineering societies and clubs that represent a combined membership of more than 100,000.

American Waterworks Association.

The 40th annual convention of the American Waterworks Association will be held at the Windsor Hotel, Montreal, June 21-25. The entertainment committee, the ladies entertainment committee, the waterworks manufacturers' association, the exhibit committee and the transportation committee have collaborated to prepare a very attractive program for technical and social activities, which include a concert, a reception with dancing and refreshments, golf, shopping and sight seeing parties for the ladies, a trip through the famous Lachine Rapids, a smoking concert and cabaret, a visit to the filtration plants of the city of Montreal and to the Montreal Water & Power Company and a three days' trip to the Saguenay River and return. This trip through a region of unusual beauty offers a charming finale to the convention.

Important reports will be received from the principal standing committees: Private Fire Protection Service, Nicholas S. Hill, Jr., chairman; representatives in American Committee on Electrolysis, Alfred D. Flinn, chairman; Standard Specifications for Water Meters, Caleb M. Saville, chairman; Official Standards for Water Analysis, Jack J. Hinman, Jr., chairman; Cold Weather Troubles, Charles R. Bettes, chairman.

The general program of regular sessions will include discussions on: What Is the Proper Size of Meter for Multiple Family Houses, introduced by short papers by H. P. Bohmann, G. A. Elliott, D. W. French and W. R. Edwards; What Is the Legitimate Use of Water, introduced by short papers by A. W. Cuddeback, C. M. Saville, and W. W. Brush, and important papers on The Municipal Water Supply of Montreal, Thomas W. Lesage; The Works of the Montreal Water and Power Company, F. H. Pitcher; The Experience in Montreal in the Manufacture of Alum, James O. Meadows; The Water Works of the City of Quebec, Arthur Surveyer; Water Supply Problems in the Province of Quebec, T. J. Lafreniere; The Water Works of St. John, New Brunswick, Frank A. Barbour; Water Works Experiences, Beekman C. Little; Economic Features of Pumping Station Operation, Leonard A. Day (illustrated with lantern slides); Difficulties in Building the Louisville Pumping Station, James B. Wilson (illustrated with

lantern slides); The New Water Supply of Winnipeg, James H. Fuertes and William G. Chase; President's Address, Carleton E. Davis; Testing Meters in Series, introduced by short papers by J. A. Murray, C. M. Saville and Fred B. Nelson; Experience with Compound Meters, introduced by short papers by C. M. Saville and Seth M. Van Loan; The Prevention of Water Waste on Railroads, C. R. Knowles (illustrated with lantern slides); Some Aspects of Electrolysis, Dr. Gellert Alleman (illustrated with lantern slides); The Revenue Chargeable to Public Uses of Water in the City of Rochester, Stephen B. Story; Damage to Deep Wells by Sea Water, Dr. Wm. P. Mason; Cost-Plus Contracts in Water Works Construction, G. W. Fuller; The War Burden of Water Works in the United States Continues, Leonard Metcalf.

The chemical and bacteriological section has a program devoted to the quality of water with papers on Quality of Water, George A. Johnson; Standards of Quality of Water, Jack J. Hinman, Jr.; Index Numbers and the Scoring of Water Supplies, Abel Wolman; Recent Progress in the Fight Against Typhoid Fever, W. J. Orchard; Controlling Water Purification Plants in the Province of Quebec, Mac H. McCready; The Operation of Small Water Works Plants from the Viewpoint of the Quality of the Water, Paul Hansen; Co-operative Research in Water Purification, Abel Wolman.

The principal officials of the society are: President, Carleton E. Davis, Chief, Bureau of Water, Philadelphia, Pa.; vice-president, Capt. M. L. Worrell, U. S. Army, Camp Dix, Wrightstown, N. J.; treasurer, James M. Caird, chemist and bacteriologist, Troy, N. Y., editor; John M. Goodell, 106 Lorraine avenue, Upper Montclair, N. J.; secretary, J. M. Diven, 153 W. 71st street, New York, N. Y.

City Planning Conference.

At the twelfth national conference on city planning in Cincinnati, April 19-22, Nelson P. Lewis, New York, was elected president and Flavel Shurtleff, Boston, was re-elected secretary. Among the topics discussed were the importance of coordination between trunk highways and city thoroughfares; Cincinnati's Rapid Transit system and the city plan; Cincinnati's highway system and the city plan; railroad terminals and their relations to the city plans; city railroad terminal planning, and the urban auto problem.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations.

AUTOMATIC SHOVELING

The patent automatic mechanical shovel manufactured by the Myers-Whaley Company, is especially adapted for handling muck in tunnels and for handling shattered rock in tunnels or open trenches or to handle loose materials between stock piles, wagons and bins. It is a self-propelling machine. The No. 4 size weighs about 18,500 pounds, is from 22 to 26 feet long, 5 feet 4½ inches wide, 4 feet 9 inches high, is driven by a 20 h. p. motor or by compressed air, and has a capacity of 45 cubic feet per minute in loose materials, of which, under ordinary conditions, it loads from 200 to 300 tons in 8 hours, including movement of cars and machines. The full crew required is one operator, one car coupler, and one driver or motorman to shift the cars. It is estimated to save two-thirds of the cost of shoveling, and to consume 0.22 k. w. hours per ton of material shoveled. One machine and crew will replace from 15 to 20 hand shovelers.

The machine itself can be operated by one man, is self-propelling, forward and backward, runs on a track or may be equipped with traction wheels, will work on either straight or curved tracks or on a smooth or rough floor and will deliver material to cars immediately

behind it or on either side of the track.

The shovel is actuated by a crank rotating continuously in one direction which is supported on a curved track which enables it to move downward, forward, upward and be revolved to discharge its contents onto the inclined conveyor in the rear at the rate of 13 times per minute for large machines and 18 times per minute for smaller ones.

Graphic Record Supplies.

The Educational Exhibition Company catalogs special supplies chiefly for graphic records for the use of executives, sales-managers, advertising managers, draftsmen, accountants, engineers, secretaries of commercial organizations and others. Prominent items in the list are outline maps with state and county divisions and special Edexco mountings that consist of four crossed layers of cellular boards covered with a layer of cork and enclosed in oak frames, making a very light and rigid bed for the map. A full line of markers consisting of pins with colored glass heads, numbered heads, special heads, and gummed paper symbols, letters and figures that can be attached to the maps are also listed. There are also for sale drafting materials, loose-leaf chart outfits, counting

machines, stop watches, swinging leaf display fixtures, and various books on statistics and graphic presentation.

The W. B. Sullivan & Sons Company, Columbus, Ohio, has issued a circular descriptive of their organization for executing in its entirety many different kinds of construction work, grouped under the general divisions of Street Grading, Pike and Roadbuilding, Asphalt Plant; Railroad Construction, Viaduct Construction, Bridge Construction; Electric Light and Power Plants, Filtration Plants, Sewage Disposal Plants; Sewer Construction, Water Line Construction, Gas Line Construction, Sidewalk Grading and Paving, General Construction Work; Cellar Excavating, General Excavating, Dredging, Foundation Walls and Retaining Walls. The circular is illustrated by numerous halftones of important work under construction including concrete reservoirs, bridges, and massive walls, steel bridge and viaduct erection, foundations and tunneling.

Sewer Pipe Joints

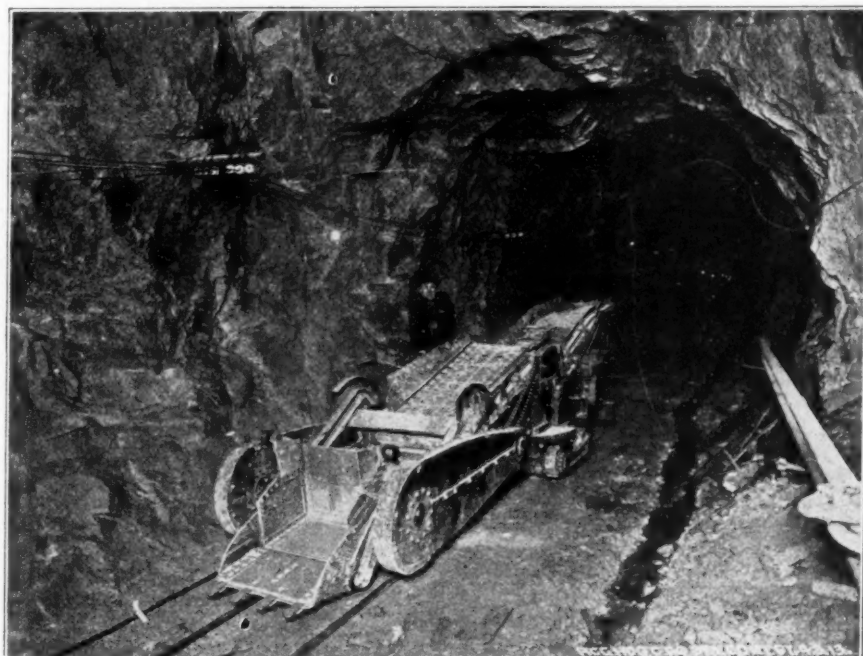
The use of G. K. for making joints in sewer pipes is urged by the Atlas Mineral Products Company in a pamphlet entitled Infiltration and Leakage in Sewers. This estimates that in an 8-inch sewer made with standard cement pipe joints costing 10c. per joint there will be a leakage into the sewer of 5,500,000 gallons of ground water per year per mile, the pumping of which will cost at least \$55, while the increased cost of making the joints with G. K. instead of cement mortar will only be \$52.80.

The joint compound is heated on the job until it is so thin so as to flow like water. In trench work, the joint is formed with the aid of asbestos runner moistened with puddled clay and clamped in position.

INDUSTRIAL NOTES.

J. B. Adams & Company's New Branches.

J. B. Adams & Company, Indianapolis, manufacturers of road building and maintenance machinery, announce that their increased business has necessitated the establishment of several branches and warehouses in the United States and



FRONT VIEW OF SHOVEL RUN BACK FROM FACE AFTER MUCKING IN TUNNEL.

Canada that will enable them to give better service to customers and prospects.

The new branches are located at 1106 Cadiz street, Dallas, Tex., at 1000 Santa Fe street, Kansas City, Mo., and at 501 Kasota Building, Minneapolis. The establishment of these branches will facilitate the rapid filling of orders for the Adams adjustable leaning wheel graders, Adams road maintainers, road patrol scrapers, road drags, scrapers, plows and other road-building equipment.

Road Machinery Building Company Enlarged.

The Good Roads Company of Kansas City, Mo., manufacturers of high pressure atomizing road oilers, tar and asphalt spreaders, sprinklers, power flushers and other road building and maintenance machinery, was recently sold to the Good Roads Corporation, a new organization which will continue to manufacture the old line as well as other types of road machinery.

All of the active members of the new corporation have had many years of experience in the manufacture and sale of such equipment. Plans are now under way to enlarge the plants so that the production can be at least tripled. Ever since the new corporation took over the business their two experienced engineers have been studying the equipment manufactured and have made some minor improvements.

The Goods Roads Corporation is now in position to make immediate delivery of their combination high pressure atomizing road oiler, tar and asphalt spreaders and their high pressure road oilers.

An \$80,000,000 Railroad Organized in Chili.

It is reported that in Santiago de Chile a corporation is being formed with a capital of \$80,000,000 for the purpose of constructing a railway from Copiapo, already connected by railway with the Chilean port of Caldera, to Buenos Aires. It has also been announced that the Argentine Government has conceded to this concern ample facilities for making the necessary surveys and that the concession is at present under consideration. This railway will give a direct outlet to the Pacific for the agricultural and live stock products of the Northern Provinces of Argentina.

National Lime Association.

The next annual meeting of the National Lime Association will be held at the Hotel Astor in New York City, June 17 and 18. This meeting will be the big convoca-

tion of the lime industry for the year. The heavy demand for lime for all types of use, the critical car supply situation, and the need for constructive educational publicity touching lime, all will be actively considered by the convention.

PROBLEMS THAT CITIES ARE STUDYING WITH EXPERTS.

The city of Tulsa, Okla., has retained W. R. Holway, president of Holway Engineering Company as consulting engineer to advise in water and sewerage problems.

The Indianapolis Board of Public Works has authorized F. C. Lingenfelter, city engineer, to prepare plans for construction on the east side of White River to prevent damage from floods. The work will include a channel 650 feet wide and the elimination of two bends in the present alignment of the river and other work calculated to protect several bridges. Work will be commenced immediately and will cost about \$2,000,000.

Cooper, H. L. & Company, have been appointed consulting engineers of the new hydro-electric plant and dam under construction by the U. S. Government at Muscle Shoals of the Tennessee River.

PERSONALS.

Bradbury, Bion, formerly commissioner of public works of Portland, Me., died May 16.

Johnson, W. J., contractor for canal construction, roads, sewers and grading, died recently at Utica, N. Y.

Fraim, J. B., bridge builder and formerly superintendent of erection for the Pennsylvania Steel Company, died May 9.

Foley, Timothy, a prominent railroad contractor in Canada and in the Northwest, died at St. Paul, May 25.

Alspaugh, E. L., has been appointed chief of parks for the United States Bureau of Public Roads, headquarters at Missoula, Mont.

Wallace, Frank, has been appointed resident engineer at Missoula, Mont., for the U. S. States Bureau of Public Roads.

Baker, H. S., has been appointed engineer of Spokane County, Wash.

Renshaw, C. A., civil engineer of Roundup, Mont., has been elected mayor of Roundup.

Caur, O. E., has been appointed city manager of Dubuque, Ia.

Evans, E. M., has been city engineer of Norwich N. Y.

Robertson, F. S., has been appointed general manager of the Cameron County water improvement district No. 2, with headquarters at San Benito, Tex.

Howell, D. J., has been appointed chief engineer of the Arlington District, Alexandria County, Virginia.

Collins, William, has been appointed city engineer of Decatur, Ill.

Hay, A. K., has been appointed engineer and secretary of the Ottawa, Canada, Suburban Road Commission.

Strohm, L. E., has been appointed city engineer of Kent, Wash.

Butterfield, D. T., has been appointed commissioner of public works at Utica, N. Y.

Parker, Arthur, has been appointed city engineer of Cheyenne, Wyo.

Martin, J. A., has been appointed commissioner of public works, Detroit, Mich.

Jeffries, E. H., has been appointed city engineer at Manteka, Cal.

Weymouth, F. E., has been made chief engineer of the U. S. Reclamation Service, after having served several years as chief of construction.

Sanders, C. L. B., has been elected city engineer of Gainesville, Ga.

Martin, F. A., assistant county engineer of Shawnee County, Kansas, recently died at Waukesha, Wis.

Woolf, Albert E., died in New York City, April 19. He was at the head of the Woolf Laboratories and had been prominently identified since the early attempts in the treatment of water and electrolytical treatment of water and sewage. Nearly 30 years ago he produced hypo-chloride under the name of electrozone and built a plant for its use in the treatment of the sewage at Danbury, Conn.

Martin, F. A., formerly city engineer of Webb City, Missouri, and later assistant engineer of Shawnee County, Kansas, died at Waukesha, Wisconsin, Jan. 29.

Green, Adolph, bridge contractor, of the Adolph Green Construction Company, died at Greenbay, Wis., Feb. 27.

Hamlin, Homer, of Los Angeles, who died recently, had, since he entered the city engineer's office at San Diego, Cal., in 1887, been employed on much municipal work, including the construction of the city's sewerage system, and in charge of paving, sewer and water works. He made designs for sewers, dams and tunnels and had recently been specially occupied on the compilation of reports for the United States Reclamation Service and for the Water Users Association.